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NOTES ON STAR-STREAMS.

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(*With a Coloured Plate.*)

To those who rightly appreciate its meaning, the Milky Way is the most magnificent of all astronomical phenomena. However opinions may vary as to the configuration of the star-streams composing this object, no doubt now exists among astronomers that the Milky Way is really a bed of suns, some doubtless, falling short of our own sun in brilliancy, but many probably surpassing it. Around these suns, we may fairly conceive, there revolve systems of dependent orbs, each supporting its myriads of living creatures. We have afforded to us a noble theme for contemplation, in the consideration of the endless diversities of structure, and of arrangement, which must prevail throughout this immensity of systems.

I propose to examine what is known of this marvellous object, and to present some considerations which appear to me to have an important bearing on the views we should form of its structure.

As the complete figure of the Milky Way is not easily gathered from most star-maps that I have met with, and is incorrectly delineated in many, I have drawn out, in Figs. 1 and 2, that zone of the heavens which contains the Milky Way. The advantage of selecting a zone, in this way, is that the whole object can be presented with very little distortion. If the strips represented in the figure were connected, and the long strip thus formed were bent into a circular belt, the complete figure of the galaxy (as exhibited on a celestial globe) would be satisfactorily represented. Owing to the irregularity of the object, it was not possible to include the whole (and also certain stars necessary to the treatment of the subject), without selecting a zone along which the galaxy is not absolutely central. I think, however, that the reader will find little difficulty on this account.

The figure here given to the Milky Way, is that I have adopted in my star-maps, my authorities being chiefly Johnstone's Atlas of Modern Astronomy, and Sir J. Herschel's description of the galaxy; but in the northern portion the figure given in the Society's maps has occasionally been followed. I will here epitomize Herschel's description, the most complete yet given. The reader will see that it corresponds closely with the configuration adopted in the illustrative figures.

The galaxy traverses the constellation Cassiopeia. Thence it throws off a branch towards α Persei, prolonged faintly towards the Pleiades. The main stream, here faint, passes on through Auriga, between the feet of Gemini and the bull's horns, over Orion's club, to the neck of Monoceros. Thence, growing gradually brighter, the stream passes over the head of Canis Major, in a uniform stream, until it enters the brow of Argo, where it subdivides. One stream continues to γ Argus, the other diffuses itself broadly, forming a fan-like expanse of interlacing branches which terminate abruptly in a line through λ and γ Argus. Here there is a gap, beyond which the Milky Way commences in a similar fan-shaped grouping, converging on the brilliant (and in other respects remarkable) star, η Argus. Thence, it enters the Cross by a narrow neck, and then directly expands into a broad, bright mass, extending almost to α Centauri. Within this mass is a singular cavity known as the Coal-sack. At α Centauri the Milky Way again subdivides, a branch running off at an angle of 20°, and losing itself in a narrow streamlet. The main stream increases in breadth, until "making an abrupt elbow," it subdivides into one continuous but irregular stream, and a complicated system of interlacing streams covering the region around the tail and following claw of Scorpio. A wide interval separates this part of the galaxy from the great branch on the northern side, which is seen in Fig. 2, terminating close on β Ophiuchi.

The main stream, after exhibiting several very remarkable condensations, passes through Aquila, Sagitta, and Vulpecula to Cygnus. In Cygnus there is a "confused and patchy" region, marked by a broad vacancy, not unlike the Coal-sack. From this region there is thrown off the offset to β Ophiuchi already mentioned; the main stream is continued to Cassiopeia.

There only remains to be noticed "a considerable offset or protuberant appendage," thrown from the head of Cepheus directly towards the pole.

A word as to the changes in the appearance and position of the Milky Way from month to month, at any given hour. Selecting ten o'clock in the evening, as the most convenient hour, we have the following variations of configuration:—At the winter solstice the Milky Way passes nearly through the

zenith, crossing the horizon towards the south-east and north-west. Its brightest part is low down towards the last named quarter, where the constellation Cygnus lies close to the horizon. One month later, the Milky Way crosses the horizon towards the south-south-east, and north-north-west, and is bowed some 20° from the zenith towards the west-south-west. Cygnus is now half-set. Yet another month, and the Milky Way is found crossing the northern and southern points of the horizon, and bowed about 40° from the zenith towards the west—Cygnus more than half set. At the Vernal Equinox, the Milky Way crosses the horizon towards the south-south-west, and north-north-east, and is bowed upwards of 50° from the zenith towards the west-north-west. One month later (that is about the 20th of April), and we find the Milky Way crossing the horizon towards the west somewhat southerly, and towards the east somewhat northerly, and only raised about 20° above the northern horizon. It is now easy to follow the remaining changes without special comment. The eastern end travels southwards, the western northwards, along the horizon, the central part approaching the zenith, just as hitherto it has been seen to leave the zenith. The bright parts in Cygnus and Aquila are more and more favourably seen as they approach the zenith, being best seen in July and August (at 10 P.M.). About this time we see the southern portion of the Milky Way somewhat beyond Antares (the heart of Scorpio), whereas six months before the greatest range on the opposite side (including nearly the whole of the gap in Argo) had been visible. At the end of October the Milky Way (at 10 P.M.), is seen vertically overhead, and crossing the horizon towards the east and west quarters, the western half being the most conspicuous.

Galileo was the first to prove, though earlier astronomers had entertained the notion, that the Milky Way is composed of a vast number of stars, crowded closely together. But no attempt was made to offer a theory of its structure until in 1754, Thomas Wright, in his "Theory of the Universe," propounded views closely according with those entertained at the present time. This philosophic observer, having examined a portion of the galaxy with a reflecting telescope, only one foot in focal length, came to the conclusion that our sun is in the midst of a vast stratum of stars; that it is when we look along the direction in which this stratum extends, that we see the zone of light constituting the Milky Way; and that as the line of sight is inclined at a greater and greater angle to the mean plane of the stratum, the apparent density of the star-grouping gradually diminishes.

But it is to Sir W. Herschel, and the supplementary labours of Sir J. Herschel, that we owe the more definite views at

present entertained respecting the Via Lactea. The elder Herschel, whose nobly speculative views of nature were accompanied by practical common sense, and a wonderful power of patient observation, applied to the heavens his now celebrated method of gauging. He assumed as a first principle, to be modified by the results of observation, that there is a tolerable uniformity in the distribution of stars through space. Directing his twenty-feet reflector successively towards different parts of the heavens, he counted the number of stars which were visible at any single view. The field of view of this reflector was 15′ in diameter, so that the portion of the sky included in any one view was less than one-fourth of that covered by the moon. He found the number of stars visible in different parts of the heavens, in a field of view of this size, to be very variable. Sometimes there were but two or three stars in the field; indeed, on one occasion he counted only three stars in four fields. In other parts of the heavens the whole field was crowded with stars. In the richer parts of the galaxy as many as 400 or 500 stars would be visible at once, and on one occasion he saw as many as 588. He calculated that in one quarter of an hour 116,000 stars traversed the field of his telescope, when the richest part of the galaxy was under observation. Now, on the assumption above-named, the number of stars visible when the telescope was pointed in any given direction was a criterion of the depth of the bed of stars in that direction. Thus, by combining a large number of observations, a conception—rough, indeed, but instructive—might be formed of the figure of that stratum of stars within which our sun is situated.

One section of the galactic nebula, as determined from Herschel's observations, is given in Figure 3. The projections extending to the left correspond to those portions of the

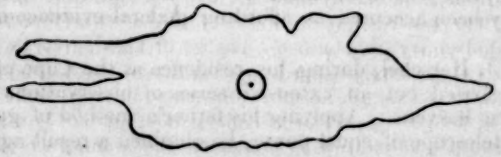


Fig. 3.

particular great circle considered, which cross the double part of the Milky Way; the opposite projection represents the portion crossed by the single stream; while the comparative flattening of the central part indicates the gradual diminution of star-density in directions removed from the galactic zone. It is, of course, to be understood that Herschel was far from

supposing that such a figure correctly represented the figure of the section. He looked upon it as affording but a rough indication of the true figure. He had indeed noticed, so early as 1785, that there is a tendency in the Milky Way to cluster around definite regions of the heavens; and he saw that the fact of such clustering was sufficient to account for many irregularities of the figure, quite irrespectively of the absolute extent of the Milky Way in space. If we are looking from a height at the lights of a large town, we may fairly assume that a row of many lights very closely ranged, lies at a greater distance from us than another row containing lights more widely dispersed, *if* we have reason to suppose that throughout all the streets of the town the lights are separated by distances approximately equal. But if we have reason to suspect that there are some streets lighted more fully than others, the inference would be no longer valid. And, again, Herschel suspected that there are stars so large, as to bear a sort of sway among other stars by superior attractive influence. Here, then, was another element of difficulty, since it becomes clear (1) that the brilliancy of a star is no positive evidence of proximity; and (2) that there may be (besides the obvious clusterings already considered) laws of systematic distribution, which might largely modify the evidence afforded by star-gauging. For instance, returning to the illustration given above, if we have reason to suspect that there are many lights of superior brilliancy, in some parts of a town, and that further there are in some streets laws of arrangement among the lights, or that there are irregularities of surface-contour, which produce here and there a greater or less foreshortening than would result on a level ground, we should have to make allowance for these points in attempting to form an estimate of the distances at which the different parts of the town are removed from us.

Still, the results obtained by Sir W. Herschel have very properly been accepted as affording general evidence of high value.

Sir J. Herschel, during his residence at the Cape of Good Hope, carried out an extensive series of observations of the southern heavens. Applying his father's method of gauging, with a telescope of equal power, he obtained a result agreeing, in a most remarkable manner, with those obtained by Sir William Herschel. It appeared, however, that the southern hemisphere is somewhat richer in stars than the northern, a result which has been accepted as indicating that our system is probably somewhat nearer the southern than the northern part of the galactic nebula.

Combining the results obtained by the two Herschels, we should assign to the stratum of stars a figure somewhat resem-

bling that of the solid cloven disc exhibited in Figs. 4 and 5. The latter figure, being a side view, gives the figure of the

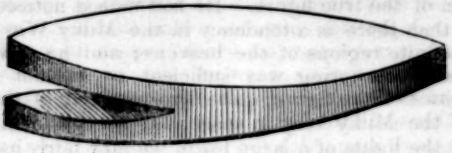


Fig. 4.

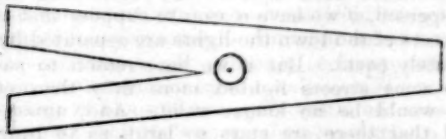


Fig. 5.

imaginary section which appears so often in works on astronomy. In Figs. 3 and 5 the small circle near the centre indicates the probable extent (on the theory in question) of the sphere within which stars down to the fourth magnitude may be supposed to be included.

The main difficulties in attempting to form an estimate of the real configuration of the galactic nebula are those which have been already mentioned. Have we evidence confirming or disproving (1) the tendency to clustering suggested by the elder Herschel, (2) the possible variability among star-magnitudes, and (3) of influences exerted by large stars in guiding or swaying others? It appears to me that there are indications of a very obvious and important character, which have been either altogether unnoticed, or much less noticed than they deserve. In considering these indications, I would refer the reader chiefly to Figs. 1 and 2; but some portions of the evidence cannot be thoroughly understood without reference to star-maps, in which (at a single view, if possible) the course of the Milky Way is exhibited in a manner which enables us at once to determine its relations to the constellations not included in these figures. I write with my black star-maps before me, my object being to consider the special evidence afforded by stars of the leading magnitudes. It may seem (and, indeed, on the assumption of any approach to uniformity in the true magnitudes, or distribution of stars, it must necessarily be) a very imperfect method to refer to star-maps including only the first five magnitudes, still more to consider the first four magnitudes which are alone represented in Fig. 1. It is

obvious that if our sun is placed within such a stratum as is exhibited in Figs. 3, 4, and 5, no evidence whatever as to the structure of that stratum can be afforded by considering the comparatively few stars included within the small central circle. But it is this very fact on which I wish to dwell. If any connection *does* appear between the configuration of our galaxy, and the arrangement of stars which are assumed to be much nearer to us than the Milky Way, it will be obvious that we must somewhat modify the views illustrated by these figures.

Now, taking Figs. 1 and 2, I think one can trace a connection between the stars there depicted, and that stream of nebulous light which the view we are examining teaches us to consider as at an indefinite distance beyond those stars. In the northern portion, perhaps, the connection is not very remarkable. We see that a large number of the brighter stars lie on or near the Milky Way, but it would require the examination of a somewhat wider zone than that here presented to exhibit this arrangement as positive evidence of aggregation. However, I think no one who has attentively examined the glories of Orion, the richly-jewelled Taurus, the singular festoon of stars in Perseus, and the closely-set stars of Cassiopeia, but must have felt that the association of splendour along this streak of the heavens is not wholly accidental. The stars here seem to form a system, and a system which one can hardly conceive to be wholly unconnected with the neighbouring stream of the Milky Way. But in the southern portion the arrangement is yet more remarkable and significant. From Scorpio, over the feet of the Centaur, over the keel of Argo, to Canis Major, there is a clustering of brilliant stars, which it seems wholly impossible not to connect with the background of nebulous light. It is noteworthy, also, that this stream of stars merges into the stream commencing with the group of Orion already noticed. Nor is this all. It is impossible not to be struck by the marked absence of stars in that region of the sky which lies in the upper right-hand corner of Fig. 2. One has the impression that the stars have been attracted towards the region of the stream indicated, so as to leave this space comparatively bare.

Now, this last circumstance would appear less remarkable if the paucity of stars here noticed were common also in parts of the heavens far removed from the Milky Way. But this is not the case. Beyond this very region, which we find so bare of stars, we come upon a region in which stars are clustered in considerable density, a region including Crater, Corvus, and Virgo, with the conspicuous stars Algores, Alkes, and Spica. But, what is very remarkable, while we can trace a connection between the stream of bright stars in Fig. 2, and the stream

of nebulous light in the background, it is obvious that the two streams are not absolutely coincident in direction. The stream lies (in the figure) above the Milky Way near Scorpio, crosses it in the neighbourhood of Crux, and passes below it along Canis Minor, Orion, and Taurus. Does the stream return to the Milky Way? It seems to me that there is clear evidence of a separation near Aldebaran, one branch curving through Auriga, Perseus, and Cassiopeia, the other proceeding (more nearly in the direction originally observed) through Aries (throwing out an outlier along the band of Pisces), over the square of Pegasus, and along the streams which the ancients compared to water from the urn of Aquarius (but which in our modern maps are divided between Aquarius and Grus). The stream-formation here is very marked, as is evident from the phenomenon having attracted the notice of astronomers so long ago. But modern travels have brought within our ken the continuation of the stream over Toucan, Hydrus, and Reticulum (the two latter names being doubtless suggested by the convolutions of the stream in this neighbourhood). Here the stream seems to end in a sort of double loop, and it is not a little remarkable that the Nubecula Major lies within one loop, the Nubecula Minor within the other. It is also noteworthy that from the foot of Orion there is another remarkable stream of stars, recognised by the ancients under the name of the River Eridanus, which proceeds in a sinuous course towards this same region of the Nubeculæ.

Having thus met with evidence—striking at least, if not decisive,—of a tendency to aggregation into streams, let us consider if, in other parts of the heavens, similar traces may not be observable. We traced a stream from Scorpio towards Orion, and so round in a spiral to the Nubeculæ. Let us now return to Scorpio, and trace the stream (if any appear) in the contrary direction. Now although over the northern hemisphere star-streams are not nearly so marked as over the southern, yet there appears a decided indication of stream-formation along Serpens and Corona over the group on the left hand of Bootes to the Great Bear. A branch of this stream, starting from Corona, traverses the body of Bootes, Berenice's Hair, the Sickle in Leo, the Beehive in Cancer, passing over Castor and Pollux in Gemini, towards Capella. A branch from the feet of Gemini passes over Canis Minor, along Hydra (so named doubtless from the obvious tendency to stream-formation along the length of this constellation), and so to the right claw of Scorpio. Four small stars of Hydrus are indicated in Fig. 2 between Scorpio and Centaurus near the upper edge of the figure.

One other remarkable congeries of stars is to be mentioned.

From the northern part of the Milky Way there will be noticed a projection towards the north pole from the head of Cepheus. This projection seems to merge itself in a complex convolution of stars forming the ancient constellation Draco, which doubtless included the ancient (but probably less ancient) constellation Ursa Minor. After following the convolutions of Draco, we reach the bright stars Alwaid and Etanin (β and γ) of this constellation, and thence the stream passes to Lyra, where it seems to divide into two, one passing through Hercules, the other along Aquila, and curving upwards (see Fig. 1) into the remarkable group Delphinus.

The streams here considered, include every conspicuous star in the heavens. But the question will at once suggest itself, whether we have not been following a merely fanciful scheme, whether all these apparent streams might not very well be supposed to result from mere accident. Now, from experiments I have made, I am inclined to believe that in any chance distribution of points over a surface, the chance against the occurrence of a single stream so marked as that which lies (in part) along the back of Grus, or (to take one within our figure) as the curved stream of bright stars along Scorpio, is very great indeed. I am certain that the occurrence of *many* such streams is altogether improbable. And wherever one observes a tendency to stream-formation in objects apparently distributed wholly by chance, one is led to suspect, and thence often to detect the operation of law. I will take an illustration, very homely perhaps, but which will serve admirably to explain my meaning. In soapy water, left in a basin after washing, there will often be noticed a tendency to the formation of spiral whorls on the surface. In other cases there may be no spirality, but still a tendency to stream-formation. Now, in this case, it is easy to see, that the curved bottom of the basin has assisted to generate streams in the water, either circulating in one direction, or opposing and modifying each other's effects, according to the accidental character of the disturbance given to the water in the process of washing.* Here, of course, there can be no doubt of the cause of the observed phenomena; and I believe that in every case in which even a single marked stream is seen in any congeries of spots or points, a little consideration will suggest a regulating cause to which the peculiarity may be referred.

It is hardly necessary to say that, if the stream-formation

* Sometimes, a singular regularity of curvature is noticed, and a spiral is formed closely resembling in configuration some of the great spiral nebulæ, as drawn by Lord Rosse, so that one is tempted to see in the centrifugal tendency of the disturbed water, and the centripetal effects caused by reflection from the basin's surface, causes which may in some sense illustrate the laws operating in wider domains of space.

I have indicated is considered to be really referable to a systematic distribution, the theory of a stratum of stars distributed with any approach to uniformity, either as respects magnitude or distance must be abandoned. It seems to me to be also quite clear that the immense extent of the galaxy as compared with the distances of the 'lucid' stars from us, could no longer be maintained. On this last point we have other evidence, which I will briefly consider.

First, there is the evidence afforded by clusterings in the Milky Way. I will select one which is well known to every telescopist, namely, the magnificent cluster on the sword-hand of Perseus. No doubt can be entertained that this cluster belongs to the galactic nebula, that is, that it is not an *external* cluster: the evidence from the configuration of the spot and from the position it occupies, is conclusive on this point. Now, within this spot, which shows no stars to the naked eye, a telescope of moderate power reveals a multitude of brilliant stars, the brightest of which are of about the seventh magnitude. Around these there still appears a milky unresolved light. If a telescope of higher power be applied, more stars are seen, and around these there still remains a nebulous light. Increase power until the whole field blazes with almost unbearable light, yet still there remains an unresolved background. "The illustrious Herschel" says Professor Nichol, "penetrated, on one occasion, into this spot, until he found himself among depths, whose light could not have reached him in much less than 4000 years; no marvel that he withdrew from the pursuit, conceiving that such abysses must be endless." It is precisely this view that I wish to controvert. And I think it is no difficult matter to show at least a probability against the supposition that the milky light in the spot is removed at a vast distance behind the stars of the seventh magnitude seen in the same field.

The supposition amounts, in fact, to the highly improbable view that we are looking here at a range of stars extending in a cylindrical stratum directly from the eye—a stratum whose section is so very minute in comparison with its breadth, that, whereas the whole field within which the spot is included is but small, the distance separating the nearest parts of the group from the farthest, is equivalent to the immense distance supposed to separate the sphere of seventh magnitude stars from the extreme limits of our galaxy. And the great improbability of this view is yet further increased, when it is observed that within this spot there is to be seen a very marked tendency to the formation of minor streams, around which the milky light seems to cling. It seems, therefore, wholly improbable that the cluster really has that indefinite longitudinal extension suggested by Professor Nichol; I think, therefore, that the

milky light comes from orbs really smaller than the seventh magnitude stars in the same field, and clustering round these stars in reality as well as in appearance.

The observations applied to this spot may be extended to all clusters of globular form; and where a cluster is not globular in form, but exhibits, on examination, either (1) any tendency within its bounds to stream-formation, or (2) a uniform increase in density as we proceed from any part of the circumference towards the centre, it appears wholly inconceivable that the apparent cluster is—not really a cluster, but—a long range of stars extending to an enormous distance directly from the eye of the observer. When, in such a case, many stars of the higher magnitudes appear within the cluster, we seem compelled to admit the probability that they belong to it; and, in any case, we cannot assign to the farthest parts of the cluster a distance greatly exceeding (*proportionally*) that of the nearest parts.

Of a like character is the evidence afforded by narrow streams and necks within the galactic circle. If we consider the convolutions over Scorpio, it will seem highly improbable that in each of these we see, not a real convolution or stream, but the edge of a *roll* of stars. For instance, if a spiral roll of paper be viewed from any point taken at random, the chances are thousands to one against its appearing as a spiral *curve*, and, of course, the chance against several such rolls so appearing is indefinitely greater. The fact that we are assumed to be not very far from the supposed mean plane of the Milky Way would partly remove the difficulty here considered, if it were not that the thickness and extent of the stratum, as compared with the distances of the lucid stars must necessarily be supposed so very great, on the assumption of any approach to uniformity of distribution.

Evidence pointing the same way is afforded by circular apertures in the galaxy, or indeed by apertures of other forms, since a moment's inspection of Figs. 3 and 5 will show the improbability of any tunnelling (so to speak) through the star stratum, being so situate as to be discernible from S. Another peculiarity of these cavities is also noticeable; whereas on the borders of every one there are many lucid stars, or in some cases two or three very bright stars, *within* the cavity there is a marked paucity of stars. This phenomenon seems to indicate a much closer connection between the brighter stars, and the milky light beyond, than is supposed in the stratum theory. One can hardly conceive the phenomenon to be wholly accidental.

There are some other points on which I would fain dwell, but space will not permit me. I may, perhaps, on another

occasion, return to the consideration of the subject. For the present, I will merely note that there are peculiarities in the distribution of double and multiple stars, in the position in which temporary stars have made their appearance, and in the distribution of nebulæ, which seem very worthy of notice.

One point, however, immediately connected with my subject, remains to be mentioned. I have traced streams of stars *more* conspicuous than those forming the Milky Way: we have also evidence of streams of light yet more delicate and evanescent than the light of our galaxy. In Sir John Herschel's great work on the southern skies, he notes the frequent recurrence of "an exceedingly delicate and uniform dotting, or *stippling* of the field of view by points of light too small to admit of any one being steadily or fully examined, and too numerous for counting, were it possible so to view them." In thirty-seven places he detected this remarkable and significant phenomenon; a phenomenon so faint, that he says, "The idea of illusion has continually arisen subsequently;" an idea well befitting the modesty of the philosophic observer, but which those who appreciate Sir John Herschel's skill as an observer will be very unwilling to accept. As Professor Nichol remarks, "It is enough to read from Herschel's note-book—'I feel satisfied the stippling is no illusion, as its dark mottling moves with the stars as I move the tube to and fro'—to feel convinced that the phenomenon is real." Now, a remarkable fact connected with those observations is, that when Sir J. Herschel marked down in a star-chart the places in which he had detected this nebulous appearance, he found that, "with the exception of *three*, which appeared outlying and disconnected, they formed several *distinct but continuous streams*."

JAPAN, AND ITS CURRENCY.

BY JOSEPH NEWTON, H. M. MINT.

It is highly probable, if it be not morally certain, that, ere many years shall have passed away, the thick veil of mystery which has so long, and so effectually concealed from us an exact knowledge of the laws which govern, and the peculiar habits which distinguish the inhabitants of Japan, will be removed. Such a consummation we believe must result from the more enlightened, and, it may also be said, far more rational mode of conducting negotiations with the authorities of that strange empire of islands which now prevails. This country, indeed, is particularly fortunate at present in having as its chief representative at the Court of the Tycoon so able a diplomatist, and so dispassionate a man as Sir Rutherford Alcock. If it be true that—

> "A wise physician skilled our woes to heal,
> Is more than armies for the public weal,"

it is equally certain that a talented and honest statesman may contribute largely to the promotion of the social and commercial intercourse, and the happiness of nations. In time past it has been too much the custom for ambassadors and others, while "dressed in a little brief authority," to play very "fantastic tricks" indeed with those to whom they were accredited, and thus to create, or widen breaches instead of promoting peace and confidence. The fact, which is sustained by abundant evidence, has had the effect, in too many instances, of preventing instead of aiding the extension of commerce, and thereby arresting the progress of civilization and of Christianity itself.

The manner in which our intercommunication with the Japanese has been conducted during the last few years is happily not amenable to any such painful criticism. Confidence, it has been truly asserted, is a "plant of slow growth," but it appears to be one in process of rapid cultivation between England and Japan, and we all know the value of the production when fully matured. At this moment, there are in this country many intelligent young Japanese, some of them of noble birth, and destined for future legislators, under course of educating and training in Great Britain, whilst several of the vexatious restrictions which heretofore prevented the admission of Englishmen into Japan have disappeared. In short, a quiet and gradual, yet sure and steady revolution in

these directions is going on, and its course is fraught with advantage to the peoples of both countries.

In the magnificent exhibition of fruits and flowers of the world's industrial gardens, now in full display at Paris, a considerable section is devoted to the exposition of articles from Japan. This forms, indeed, one of the most interesting portions of the wondrous show, and the ingenuity and originality manifested by the artists and workpeople who have prepared the articles are extraordinary. The fact of their transmitting so much valuable property to France, and taking so palpable an interest in the success of the gigantic undertaking, is in itself a strong proof that the Japanese are becoming fully alive to the advantages of international traffic; as it certainly proves that the councils of the Tycoon are not now under the influence of the old spirit of exclusiveness. Taking this, with other signs and portents of a similar character into account, there can be little danger in predicting that closer and far more familiar relations between the states of Europe generally and Japan will soon exist. Such a result cannot but be productive of good to all, and we hail its approach as a certain guarantee of increasing commercial prosperity, for this country especially.

If, however, there are externally to Japan, as it were, symptoms of an increasing intercourse such as has been indicated, there are corresponding symptoms within its own limits. To one of these latter it is proposed now to invite attention, namely, that of a proposed reformation of the metallic currency, which subject is under discussion by the Japanese Government. On matters of trade and currency which, as we so well know, have the most direct and vital bearing upon each other, the people of Japan have been instructed to some extent by the Dutch, with whom their trading transactions have hitherto been almost exclusively carried on. The information thus gained nevertheless was of a limited kind, and was probably sought for the purpose of meeting the internal wants of the country, and the consequence was the establishment of a system of coinage by no means cosmopolitan in its application, but, on the contrary, most narrow and artificial. The coinage of Japan was, however, it must be admitted, carefully devised, from one point of view, for its especial object, and its arrangement, though presenting startling anomalies to those unaccustomed to it, was not ill adapted to the daily necessities of the native population. The treaty which was completed in 1858, conjointly between Great Britain, America, and Japan, and which, to a very limited degree, opened up commerce between the three countries, first induced the Japanese to take into earnest consideration the nature and

peculiarities of their own metallic currency, and its adaptability or otherwise to the purposes of foreign trade. This consideration was a fact forced upon them by pressure of the strongest influence which it is said can operate upon traders in general—that of self-interest. To make this point more clear and intelligible, let us describe the coinage of Japan, as it was arranged at the period just cited.

The principal coins circulating anterior to 1858, were the gold *kobang*, the gold *itzebu*, and the silver *itzebu*. The original kobang of gold was worth about 18*s*. $3\frac{3}{4}$*d*., or 18*s*. 5*d*. British. The gold itzebu was worth one-third of the gold kobang, and the silver itzebu equalled in value 1*s*. 4*d*. English money. At the time of the partial opening up of foreign trading transactions, the kobang circulated in Japan at *four* itzebus, although its European value was actually nearly *fourteen* itzebus! The immediate consequence of this latter circumstance on the sharp traders of America and England, was to induce them to buy up all the kobangs that came in their way at the Japanese valuation. By this proceeding, which no doubt enlightened the poor natives, and revealed to them the truly *commercial* character of their new customers, the latter gained large sums of money. The lesson thus practically taught and forcibly illustrated, was speedily learnt by the Japanese, who set about purchasing the remaining kobangs. The result necessarily was a total disappearance of the kobang from the channels of general circulation.

At present, therefore, gold and silver itzebus are the coins which mainly do duty as the circulating media of Japan. These are supplemented, however, by a silver coin known as the *itacune*, and which is equal in value to 12*s*. British. There are also in use among the humbler classes of the native population, subsidiary pieces of copper and of iron, and which are known individually as the *sen*, or cash.* Of these 376 are required to equal in value an English shilling. The obsolete kobangs were thin and oval-shaped discs of flattened gold, two inches in length, and $1\frac{1}{4}$ inches in width. Their weight averaged 200 English grains, and their almost universal degree of fineness was $\frac{16}{20}$. The ornamentation of the kobang was of the most primitive and simple nature. A kind of scroll like a floreated design at the top, and at the bottom of the obverse, was supposed to represent the coat of arms of the *Dairi*. Characters stamped in immediately beneath the upper coat of arms indicated the exact weight and value of the coin and the date of its production. Above the lower coat of arms was the name of the Master of the Mint at which it was

* The coarsest specimens of mintage extant, and not equal to the Chinese "cash," illustrated at page 121, vol. iii. of INTELLECTUAL OBSERVER.

minted, and who thus guaranteed and made himself responsible for its genuineness.* In the centre of the reverse was the official mark of the Director-general of the gold and silver coinages, and not unfrequently the names also of private individuals were imprinted on the same side to demonstrate that the coin had passed through their balances and not been "found wanting."

The gold itzebu, or, in the more vulgar tongue, the "itjib," weighs about 60 English troy grains, and its degree of fineness is $\frac{569}{1000}$. It is simply an oblong piece of gold plate metal, with rectangular ends admirably adapted for cutting holes in pockets. It is $\frac{3}{4}$ of an inch in width, and ornamented by a coat of arms, characters exemplifying its weight and value, and other official marks of the director of coins. The *itacune* is an oval-ended plate of silver, three inches in length, $1\frac{1}{2}$ inches in width, weighing 1160 English troy grains, and possessing a degree of fineness equal to $\frac{656}{1000}$. It is stamped with the Imperial arms, top and bottom, with declaration of current weight and value in the middle.

As has been stated, some of the consequences of the treaty were soon *felt* in a material sense. It was ascertained that one Mexican dollar was, approximately, equal in value to three itzebus. Foreign merchants were therefore entitled to demand three itzebus in exchange for a dollar, and as, by the provisions of the same treaty, permission was given for the free export of gold and silver, the gold coins could be obtained at the Mint price for the itzebus thus acquired, they were speedily bought up and exported. Is it surprising that the Japanese soon complained that they were being robbed under the actual conditions of the treaty which thus legalized fraud? Sir Rutherford Alcock, who was a witness of these evils, strenuously endeavoured to remove, or at least to mitigate them. He advised that the Government of the Tycoon should remodel its own currency laws, and his suggestions were partially adopted. Had they been wholly acted upon, greater good would have resulted. Timidity and prejudice prevented this and half measures, as usual, ended in disaster, or at any rate in failure.

Further counsel has been recently invoked from the English Government, and while we write, vigorous attempts are being made to effect a complete re-arrangement of the Japanese currency. It would be premature to adumbrate even the nature of the bases upon which the new system of currency will be placed, but it may be predicted with safety that decimilization will be one of them. At all events, it is undoubtedly true, that the experiences of the last few years have enlight-

* An arrangement existing in this country in the days of the Saxon Heptarchy.

oned the minds of the ministers of the Tycoon in respect of the highly important matters of trade, currency, and coinage, and it is therefore more than probable that on these, as on other questions, ideas once reckoned as inadmissible, will be warmly entertained, if not willingly realized.

The currency system of Japan, during the isolation of that country for many centuries from the rest of the world, was constructed on principles and framed with views so entirely different from those adopted by other countries within the circle of general commerce, that it may well be regarded, like other institutions of that strange nation, as a puzzle. The Government was able to control the coinage as it pleased, and there were only two channels by which it was attainable—the Dutch and the Chinese establishments at Nagasaki. *Now* all this is changed, or in process of transformation, and American coins are in partial circulation throughout Japan.

It will not astonish us very much to learn that a new Imperial Mint, fitted with the best machinery and most complete apparatus which England can furnish, is ordered, or that such an establishment is actually in course of construction at Nagasaki. In this respect, at least, Japan will presently be placed on an equal footing with America and the states of Europe. Who shall predict the future history of the mysterious nation in question, or guess even at the final extent of the moral, intellectual, and physical development of its people?

FUNGI OF THE PLAINS OF INDIA.

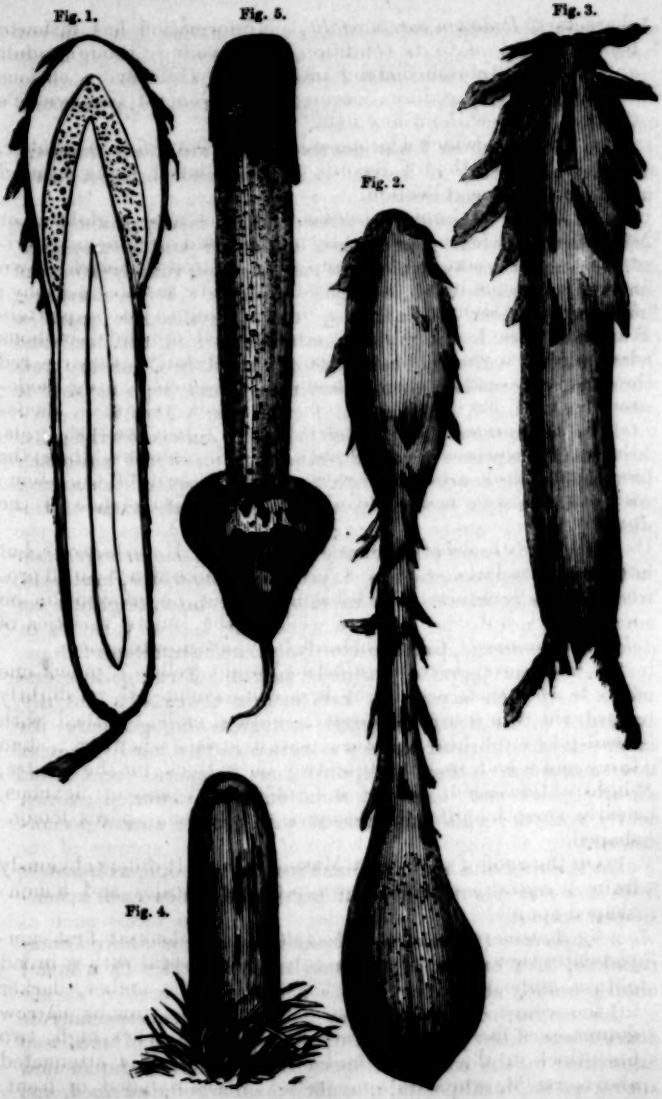
BY THE REV. M. J. BERKELEY, M.A., F.L.S.

It is curious that so little comparatively has been done respecting the fungi of India. A large collection, indeed, was made in Sikkim and the neighbouring countries by Dr. Hooker, but with this exception, and a few from the Neilgherries, Paras Nath, the Northern Himalayas, and other scattered points, scarcely any have been recorded, and indeed, the mycology of few countries had been so little explored. It is, however, quite certain from what I have seen of collections made in Bombay by Dr. H. J. Carter and Capt. J. C. Hobson, and what I have received from my son, Capt. E. S. Berkeley, from the Madras Presidency, that there is a very rich harvest in store.

This of course applies chiefly to mountainous districts. It is not to be expected that the plains of India should be equally prolific, but there are some fine undescribed species to be met with occasionally; and I have already published in the *Introduction to Cryptogamic Botany*, some curious forms from the Deccan. It is, moreover, pretty certain that one or two of our hothouse fungi, as *Agaricus volvaceus* and *Agaricus Cepæstipes*, were originally imported from thence or some neighbouring country.

Many years ago, General Hardwicke had a number of drawings of fungi prepared for him at Dum-dum. Etchings of several of these were made on their transmission to Dr. J. E. Gray, but in the midst of numerous zoological engagements, the intention of publishing them was never carried out. They of course comprise a few cosmopolites, as *Polyporus lucidus* and *Schizophyllum commune*, and some widely distributed exotics, as *Irpex flavus* and *Dædalea sanguinea*; but they are especially interesting, as (together with two of the finest species of the Volvaria sub-genus of Agaricus, known in Europe, as *Agaricus volvaceus* and *A. bombycinus*) there are at least two new species of the same division, while amongst European forms such as *Agaricus campanulatus* and *A. papilionaceus*, we have others decidedly tropical or sub-tropical, to one or two of which I shall presently draw attention.

I have, however, been induced to look more especially to these fungi of the plains of India, in consequence of receiving some drawings of a few fine species from my son, who is now quartered at Masulipatam, most of which are undescribed, and of the one which has been noticed in several quarters from its singular habitat on the nests of white ants, and its peculiar



FIGS. 1 TO 4, PODAXON CARCINOMALIS, FR. FIG. 5, PHALLUS TRUNCATUS, BERK.

characters, *Podaxon carcinomalis*, no information has hitherto been received as to its condition when young, though adult specimens are not uncommon in collections. A very curious allied genus *Xylopodium*, occurs among General Hardwicke's collection, but without any details.

The species which I propose to describe are five in number, and they all worthy of record; the two latter being figured in the Dum-dum collection.

1. *Agaricus* (Lepiota) *malleus*; pileus nearly globose or mallet-shaped when young, then expanded and hemispherical, 3-9 inches across, white and silky spotted with dark brown scales of various breadth, especially towards the disc; fleshy; flesh white; stem 3-5 inches or more high, three quarters of an inch thick in the middle; attenuated upwards, bulbous below, stuffed with a delicate cottony substance, turning red when cut, externally brownish and nearly smooth; ring moderately broad, fixed near the top; gills pale yellowish, moderately broad, remote; attenuated behind. Just above the gills, the flesh of the pileus is very dark, though elsewhere white, the dark part being continuous with the outer coat of the stem; the tip of the stem is slightly sunk into the substance of the pileus.

Allied with some other exotic species to *A. clypeolarius*, but on a scale as large as that of *A. procerus*, like which, in all probability, it is esculent. We have, however, no information on the subject, nor do we know whether the Indian varieties of *Agaricus campestris*, like those of Italy, are unwholesome.

2. *Agaricus* (Lepiota) *alliciens*, bright yellow; pileus one and a half inch across, at first campanulate, then slightly expanded with a broad extremely-obtuse umbo, clothed with small pilose red-brown scales; margin striate when dry; stem three and a half inches high, two lines thick in the centre, slightly thickened below and attenuated above, flexuous, nearly smooth; gills thin, tinged with green; spores lemon-shaped.

On the roof of a house at Masulipatam. It differs obviously from *A. cepæstipes* in the brown persistent scales and lemon-shaped spores.

3. *Agaricus* (Hebeloma) *holophlebius*; pileus at first campanulate, then expanded and sub-hemispherical with a broad obtuse umbo, above two inches across, pale umber, darker in the centre, deeply rivulose with little sinuous narrow depressions, fleshy; flesh white; stem three inches high, two lines thick in the centre, bulbous below, slightly attenuated above, pallid, white within, stuffed; gills rounded in front, shortly adnate, pinkish at first, then pale brown; spores brown, elliptic-oblong.

This is one of the most interesting Agarics with which I am acquainted. The whole pileus is veined. *Agaricus phlebophorus*, which belongs to a different sub-genus, is the only one with which I can compare it.

4. *Podaxon carcinomalis*, Fries.; *Lycoperdon carcinomale*, Linn. fil. (Figs. 1 to 4). At first cylindrical, obtuse, white with a few brown elongated adpressed scales, gradually becoming clavate above, with the scales standing out, then with a distinct elliptic head; stem nearly smooth, penetrating deeply, and surrounded within the thick peridium with the hymenium, which is at first porous like the crumb of a loaf, and then, as in a puff-ball, filled with dusty spores. Varying considerably in size, sometimes six inches or more high.

It occurs at the Cape of Good Hope, where it was originally found by Thunberg, and has lately been gathered by Dr. Welwitsch on the western coast of Africa. It is probably common in India. It is said to have been used for dressing cancerous sores in Africa, whence it derives its specific name. Our woodcut represents it in three stages of growth, together with a section of the plant while the hymenium is still young.

5. *Phallus truncatus* (Fig. 5), n.s. Volva dark brown, pointed below, where it gives off a strongish rootlet, truncate above, not lobed, but with the margin entire; stem three inches high, half an inch thick in the centre, bright sienna brown inclining to orange, porous, attenuated at the base, capped above with the connate receptacle, above three quarters of an inch high, which is slightly reticulated, broadly truncate at the apex. Sometimes the cap carries up with it a portion of the white inner membrane of the volva.

Nearly allied to *Phallus aurantiacus*, Montagne, but differing in the remarkably truncate apex and brown volva. This, with the foregoing species, is figured in General Hardwicke's drawings.

A VISIT TO GLEN CLOVA—ITS GEOLOGY AND FERNS.

BY BERNARD HENRY WOODWARD.

Clova is a village situated in the extreme north-west of Forfarshire, the most picturesque part of that county, being in the midst of the Grampian mountains. It consists of a few small farm-houses and shepherds' cottages scattered along the glen from which it derives its name, and which is about ten miles in length and stretches from N. W. to S. E. The houses are clustered a little more thickly round the church, which stands about four miles from the head of the valley; and near it, at the foot of Ben Reid, are the ruins of Clova Castle, formerly inhabited by the Ogilvy family, who have owned the parish since 1445. The present proprietor, the Earl of Airlie, one of their descendants, resides at Cortachie Castle, which we passed just before entering this glen on our road from Kirriemuir, the nearest railway station, though fifteen miles distant.

There is a good carriage-road the whole length of the glen, running by the side of the South Esk river, a fine trout stream rising in Loch Esk, a small lake at the head of Glen Bachna-gairn, and flowing into the sea at Montrose. At the lower part of Clova Glen, the hills on each side are rounded, covered with fir-trees, and are about 1500 feet high, from which they gradually rise to upwards of 3000 feet above the sea level in the upper part, where they are quite bare of trees and very wild and precipitous. The valley widens considerably for the first four miles, and then draws in again. A considerable extent of the level ground at the bottom of the valley is ploughed, though the greater portion is left for pasturage, on which a good many Highland cattle are reared; which, together with the sheep that are turned loose to browse on the hills, afford a means of support to about 200 people, the present population of the parish. Some years ago, as is testified by the many ruined cottages in the glen, its inhabitants were three or four times as numerous, when they obtained a livelihood by the distillation of "mountain-dew"; but a more strict surveillance on the part of the excise officers stopped that lucrative pursuit. Last year the oat crop turned out very badly; when we were there, in the latter part of August, many of the fields were quite green, and in some no ears were visible.

But we ought not to have said *level* ground, for it is only level in comparison, being covered with rounded hillocks, "moraines," formed of the debris deposited by the glacier which once filled this glen. Where its surface has been

ploughed, the numerous boulders of granite, with which the glen and the valley of Strathmore to the south are strewn, have been used to build dykes to separate the fields. These boulders are chiefly of syenitic granite and gneiss, of which latter rock the hills at the top of the glen are composed, while those at the lower part are mica-slate.

We noticed on ascending the glen a strange murmur, quite distinct from the rushing and splashing of the South Esk in its numerous small falls and rapids, which seemed to pervade the whole air, continually growing louder as we advanced, and we also observed that the narrow, tortuous, silvery streaks running down the sides of the hills, became more frequent, and on a close approach found that these were small streamlets, which in their headlong course caused this murmuring sound with their miniature cascades, which made up by number what they wanted in strength. A succession of falls from the summits to the feet of the hills, caused them to appear white in the distance, though here and there they formed small still pools, which were fringed with mosses, and sheltered by rocks; on their sides were growing luxuriantly the delicate Oak fern, *Polypodium dryopteris*, together with the Beech fern, *P. phegopteris*, and the Brittle Bladder fern, *Cystopteris fragilis*.

Clova Glen separates at the north-west end into two narrower but wilder glens, that to the left being called Glen Dole, and the one to the right Bach-na-gairn. There is a bad carriage-road up the latter for four miles to a shooting-box, and beyond that a bridle-road leading over the hills and down Glen Muick to Balmoral. At the head of this glen is Loch Esk, where the South Esk river has its source, and forms a fine waterfall over sixty feet in height just below the loch. The scenery all along is very grand, surpassing the famed Spital of Glenshee.

Near the loch, which is on the borders of an extensive deer-forest covering sixty square miles of country, are a number of fine larch and spruce trees, planted some fourteen years ago, to afford shelter to the deer. Craig Ought, the hill at the commencement of this glen, which separates it from Glen Dole, is extremely precipitous on this side, and at its base is an immense quantity of rock, that has been thrown down in the course of years by the disintegrating action of frost. Many of the fractures being quite fresh, we had a good opportunity for inspecting the nature of the rock, which consisted principally of felstone, porphyry, and syenite; the latter varying very much in texture, some parts being extremely fine-grained, while others contained very large crystals of hornblende. In some the quartz was almost wholly absent, and in

other parts it preponderated largely. The prevailing colour of the syenite is dark grey, and is heightened, in some places, by a considerable quantity of black mica. Higher up the glen, we found some granite containing pyrrhotine (magnetic iron pyrites), in which the felspar was flesh-coloured, as it is in the gneiss, which latter rock covers nearly the whole of Scotland to the north and west of this district.

In Glen Dole, which we explored on the Wednesday, there is not even a pathway, except those made by the sheep; and after we had passed a short distance beyond Dole farm-house, the last in Clova Glen, we did not see a single person during the whole day, until we had almost reached the same place on our return in the evening, when we saw a shepherd on the opposite hills!

Here the moraines are much more frequent and clearly defined than in Clova Glen. They are all covered, as are the hills, with heather, which was just coming into bloom. We followed the "White Water," as the branch of the South Esk flowing down this glen is called, for a couple of miles, and then turned with it up Glen Phee, where it forms a charming waterfall, or rather a succession of falls, which, at a short distance, look like one, and from the appearance of the spray give to the burn its name. The water, as is the case with all mountain streams which flow over peaty soil, is of a brownish colour. This is plainly seen in any of the numerous deep pools occurring here and there along its course, and affording good shelter for many a "lusty trout." Here we found the Brittle and the Toothed Bladder ferns, *Cystopteris fragilis* and *C. dentata*, growing luxuriantly, with the Oak and Beech ferns, *Polypodium dryopteris* and *P. phegopteris*; the two latter are very common throughout the Clova district at the bottoms of the valleys; also, in the moist crevices of the rocks, Wilson's film fern, *Hymenophyllum unilaterale*, and, higher up on the hills, splendid plants of the Holly fern, *Polystichum lonchitis*, with fronds two feet high. This was tolerably abundant; but we were unsuccessful in our search for *Woodsia ilvensis*, which has been found here by Dr. Balfour, as has also the *Woodsia hyperborea* in Glen Bach-na-gairn. The Hard fern, *Blechnum boreale*, grows to the summits of the hills, though it is rather stunted at the greater altitudes.

On Thursday we visited Loch Brandy, a mountain tarn, situated about half-a-mile to the east of the church, but at an elevation of 1300 feet above it, which made it a good hour's walk, for there is not even a foot-path up to it. On our ascent by the side of Corrie Burn, we noticed *Lastrea spinulosa*, *L. dilatata*, and *L. oreopteris*. The latter is very common throughout the district. *Polystichum lonchitis*, *P. angulare*, etc., the

Bilberry and the Mountain or Cloud-berry, *Rubus chamæmorus*, together with that pretty Alpine plant with silvery leaves, *Alchemilla alpina*, grow everywhere amongst the heather which covers the hills here; and we saw also a great many of those rare Alpine species for which Clova is such a noted locality.

Loch Brandy is about a mile and a half in circumference, and abounds in pike and trout. From the summit of the hills, which rise precipitately in a semicircle at the north of the Loch to about 700 feet above it, one obtains, on a fine day, a splendid view over the surrounding country to the south, along the Clova Glen, across the valley of Strathmore; while to the east, north, and west are to be seen nothing but mountains, and mountains beyond mountains, right away into the blue distance. A shepherd whom we met told us the names of a great many, but with such a Highland accent that we could catch only one here and there, amongst which were Loch-nagar, and Glas Miel, etc.

But we must not omit to point out the best means of access to Clova. We preferred travelling by sea from London to Edinburgh, to being shut up in a close railway carriage for twelve hours; and so took a steamer from Irongate Wharf, bound for Leith. We had a pleasant and quick passage down of only thirty-seven hours, on board the "Oscar," one of the swiftest of the Leith steamers, which are all noted for their speed, the weather being almost too calm; but on our return it was rather rough, which was a pleasant change. The "Oscar" is 240 feet long, by 30 feet broad, and of 900 tons burden. From the steamer one has a good view of a great portion of the eastern coast. We had to give the flat shore of Essex a wide berth, but approached land a little nearer when passing Suffolk and Norfolk, though almost the only objects to be seen on them were the Martello towers placed at intervals along the shore, and the two lighthouses on Orford Ness. At Cromer we first see cliffs. In crossing by the Wash we lose sight of land for some time. While passing the bold Yorkshire coast, we kept still closer to the shore, sighting Flamborough Head, at 7·15 on the Sunday morning, having left London at 10 the day before; next Filey Brig, Scarborough, with its ruined castle, Robin Hood's Bay, then Whitby, in the neighbourhood of which so many fossil ammonites are found, and of which the popular tradition runs:—

> "And how, of thousand snakes, each one
> Was changed into a coil of stone,
> When holy Hilda prayed."

The magnificent abbey, now in ruins, which forms a con-

spicuous object on the cliffs to the south of the town, was dedicated to that lady.

After this we did not see much of the land, owing to the curve of the coast-line, until we approached the Ferne and Staple Isles, and Lindisfarn, or Holy Island. The weather was so favourable that we sailed between the former and the shore. We passed within half-a-mile of St. Abb's Head just at sunset, and the sight of this fine headland alone, we felt, would have repaid us for coming by sea. The rock is a dark red colour, but, in the more sloping places, was covered with vegetation which, in the declining rays of the sun, appeared an unusually bright green; while here and there were patches of yellow lichen, and all the sheltered ledges were white with gulls, hundreds of which were flying about.

It was quite dark when we reached Tantallon Castle and the Bass Rock. We arrived at Leith at 11 o'clock the same night.

After staying a couple of days in Edinburgh and seeing a few of the "lions," including the charming Botanical Gardens, said to be the finest in Europe for their size, we took a steamer from Granton Pier to Stirling. The scenery on each side of the Forth is said to be very lovely, but as we were favoured with a Scotch mist and a little rain, we are not in a position to pass an opinion upon it. The numerous windings of the river between Alloa and Stirling, known as the "Links of Forth," are very remarkable.

We spent an hour or two looking over the Castle, which was for a long time a favourite residence of the Scottish kings, but is now used as a barrack; and a regiment of Highlanders were then stationed in it, who, in their kilts, added greatly to the picturesqueness of the scene.

It is situated on a hill, and which rises gradually from the east, but terminates abruptly in a precipice, below which is a large expanse of level country. The Wallace monument, a memorial tower now in construction on a lofty hill on the opposite side of the river, forms a conspicuous object in the landscape.

In the afternoon, we took the train on to Forfar, which we had determined to make our headquarters for a few days, for although it is in itself a very dull, uninviting town, there are several very interesting places within easy access. Our first excursion was to the famed coves and caves of Forfarshire, for which we took the train to Arbroath, where are the ruins of a fine Abbey founded by William the Lion, in 1178, who was afterwards buried in it; it was dedicated to St. Thomas à Becket. It was chiefly built in the early English or first pointed style of Gothic architecture. The church was 269 feet

long, the nave and side aisles 65 feet broad, and about 67 feet high. Portions only of the nave and choir, the east and west ends, and of the south transept, now remain, but they exhibit some beautiful mouldings and details. The abbey gateway, upwards of sixty feet long, which was only unroofed at the commencement of the present century, is of rather a later date, and shows a dawning of the decorated or second pointed style. The chapter house, the most perfectly preserved portion of the building, is of two storeys, with a short spire at the south-west angle, and is now used as a museum for any relics found among the ruins.

About twelve miles S. by E. out to sea from Arbroath is the Bell Rock Lighthouse, built under the superintendence of Mr. Robert Stephenson, on a range of rocks that rise four feet above low water at spring tides; the outer casing is of Aberdeen granite, and its height 115 feet. It was commenced in 1807, and finished in 1811.

It derives its name from the circumstance of one of the abbots of Arbroath having had a bell fixed on it to warn mariners. This was wantonly cut down by a Dutch pirate, who was afterwards, it is said, wrecked upon it, in just retribution for his misdeed.

We walked along the cliffs to Auchmithie, a small fishing village about five miles to the north. The cliffs, here composed of old red sandstone, are extremely picturesque, being much indented and broken up by the action of the sea and weather, leaving here and there insulated rocks, and containing numerous caverns which penetrate in many places through projecting portions of the cliffs. Many of the caves are occupied by the sea at all times, others at high tide only, and some are altogether out of the reach of the water. One is called the Mason's Cave, from the appearance of the rocks at its entrance, which look at a short distance as though they had been built up artifically; another the Green Cave, from the luxuriant manner in which the Hart's Tongue fern, *Scolopendrium vulgare*, grows in it. We also found in this cavern a few stunted plants of the Sea-spleenwort, *Asplenium marinum*.

On Friday we confined ourselves to the immediate neighbourhood of Forfar, in order to see the ruins of Restennet Priory, situated about a mile to the east of the town. We passed on our way the source of the Lunan, a stream that originates at the head of Restennet marshes. It flows into the sea in Lunan Bay, a few miles south of Montrose, forming in its course Roscobie and Balgaries Lochs. Till the latter end of last century it also formed a loch where the Restennet marshes are now, and which was drained for the valuable marl it contained. The ruins of the priory of Restennet, or Rostinoth

as it was originally spelt, are situated upon a small eminence in the marsh formerly an island in the loch.

The greater part of the walls of the church are almost entire, including the tower, which is surmounted by an octagonal spire. They have lately been repaired by the proprietor. The south-east and west walls of the cloisters are in a ruinous condition. The whole building appears to have been in the first pointed style of architecture, or that which prevailed in Scotland during the thirteenth century. It is believed to have been erected on the site of the old church of Rostinoth, founded by St. Boniface when he came into Scotland in the beginning of the seventh century. Growing in these marshes, near to Clocksbriggs station, we found the Marsh fern, *Lastrea thelypteris*.

We walked round Loch Feithie on our return to Forfar, a charming little lake entirely surrounded by woods, about half a mile to the south of Restennet; but it is much choked up by the soldier-weed. This loch contains no deposits of marl, "which," says Sir Charles Lyell, "is owing to there being no springs in it." It is only where a stream enters a lake, or where it is fed by springs, which may introduce a fresh supply of calcareous matter, that shells accumulate and help to form marl. For otherwise, the thin shells of one generation of mollusks in decomposing only afford sufficient nutriment to the succeeding races.

On Saturday we walked to the *vitrified forts*, situated a little to the west of the village of Aberlemno, on the north brow of the Finhaven hills, and five miles N. E. from Forfar. These hills form the southern boundary of the vale of Strathmore, above which they rise to the height of 600 feet, and so the fort occupies a most commanding situation. The origin of these vitrified forts, of which there are several in the country, though this one is the most extensive, goes so far back into antiquity, that not only the names, but even the races of their builders are unknown. The Finhaven fort is in shape a parallelogram, having its corners rounded off. It declines with the hill to the W., in length from E. to W., 476 feet, at the E. end its breadth is 83 feet, and at the W. 125 feet; the wall is from three to ten feet in height, but is supposed at one time to have been much higher. Great quantities of the stone have been carted away for mending the roads. In the west end of the fort there was a well, but this is now filled up. The fort is built of several kinds of stone, chiefly sandstone and gneiss, which have been fused together by the action of fire, a good substitute for cement. It must have required an immense amount of wood to vitrify such a large fort, but in those days that could easily have been obtained, for the whole of this district was once covered by forest, as is shown by the quantities of old

wood that are found in the mossy and marshy grounds. In some of the hilly parts of Tartary and India, the nations still vitrify their forts instead of using cement.

We saw on our road several stone and "slate" quarries, in which we found several tails, spines, and teeth of fossil fish, but were not so fortunate as to obtain a specimen in anything like a perfect condition. The upper beds of the old red sandstone formation are very compact, and having good cleavage planes, are used as roofing-slates in the neighbourhood.

Near one of these quarries some soil had recently been removed, laying bare the surface of the rock, on which were well-defined glacial markings, and which, from their direction, had evidently been made by a glacier coming from Glens Prosen and Clova. In a field near Aberlemno are two of those curious sculptured stones, of which a good many exist in this part of Scotland, and concerning which volumes of theories have been written, conclusively proving that nothing whatever is known about them, neither by whom or for what purpose they were erected. They had figures of horses and men, and an ornament like a pair of spectacles, amongst other symbols, carved on them.

On the commencement of the following week we went by rail to Kirriemuir, a small town, six miles W. by N. from Forfar, and then drove to the Den of Airlie, twelve miles further. The Den is a most beautiful ravine, formed by the Airlie river, which flows down it. In some parts the sides are quite perpendicular, and over 400 feet in height, while in others they slope more gradually. The valley is well wooded, and in the shade and moisture many species of ferns abound, the most noteworthy of which is the Green Spleenwort, *Asplenium viride*.

We walked up the valley from Airlie Castle to the Reeky Linn, a magnificent waterfall, sixty feet in height. It is said to be one of the finest in Scotland. We returned to Kirriemuir by way of Lentrathan Loch and through Kingoldrum.

Kirriemuir is within an easy walk of Clova; and if any of our readers are in search of a place whereat to spend the holidays, we strongly recommend to their notice the latter; and to a lover of botany it is extremely attractive, for in few localities of equal size in the British isles have so many rare plants been noticed. And last, but not least, there is a very comfortable hotel, where the charges are very moderate, for at present this district has not been overrun by tourists.

ORIGIN OF THE CHEDDAR CLIFFS.

BY D. MACKINTOSH, F.G.S.

THE Mendip range of hills, in Somersetshire, presents a striking instance of a truncated anticlinal fold or axis. According to Professor Ramsay, a mass of strata nearly a mile in thickness has been cut off from the summit by denudation, exposing the old red sandstone in the middle, with the carboniferous, or mountain limestone, dipping away on both sides. The outcrop of the limestone, under the old red, has been shaped into steep escarpments, with cliffs at intervals. A very remarkable line of upland cliffs runs from the Shute-shelve pass (between Sidcot and Axbridge) to Longbottom pass, and some distance beyond. It is here and there indented by cliff-bound ravines which, were they to become partially submerged, would differ very little in shape from inlets of the sea. Nearly on a level with the summit of this line of cliffs, there is an approximately horizontal table-land, which few geologists would hesitate to regard as a "plane of marine denudation." Beyond Longbottom pass, in a south-easterly direction, this table-land becomes irregular, and its south-west escarpment, facing the Cheddar plain, is indented with combes which are more or less cliffy, especially at their inner termination. A formation of Permian conglomerate, which in most places may be found fringing the base of the Mendip Hills, runs into these combes, proving that they must have been mainly excavated before or during the Permian period. The trumpet-shaped mouth of the Cheddar ravine might be classed among these combes, were it not that it must have been formed at a subsequent period, for its floor, as well as sides, consists of carboniferous limestone. This ravine, at first sight, suggests the idea (not confirmed by farther inspection) of the limestone ridge through which it passes, having been "rent in twain" from the top to the bottom.

The Cheddar ravine, though long celebrated, deserves something more in the way of description than the very brief notices that have hitherto appeared. In the preface to a legendary article in a late number of the *Gentleman's Magazine*, it is justly regarded as "one of the most gorgeous specimens of rocky scenery to be found in Europe. . . . The eye grows accustomed to Switzerland, but Cheddar is a continual surprise."* The object of the present paper is to give some

* In the *Penny Cyclopædia* it is alluded to as follows:—". . . the defile of Cheddar cliffs, with its long line of stupendous mural precipices, certainly among the most magnificent objects of this kind in Britain. . . ."

idea of its structure and extent from personal observations, and to consider the most probable way in which it has been formed.

Immediately to the north-east of the village of Cheddar, which stands on ground only a little elevated above high-water mark, there is a combe-shaped valley. Its sides gradually contract, and become more rocky and precipitous, until it forms a narrow winding gorge, with walls of limestone. About a quarter of a mile from the village the gorge becomes very narrow, and the cliffs, especially on the right hand side, very steep and even overhanging. For some distance beyond, the road runs along what may be called the Strait of Cheddar, after passing which the ravine gradually opens, and its sides become more sloping, until it loses its rugged grandeur of outline. In the most contracted part of the Strait the observer is so completely hemmed in by bare rocks as to require little to make him fancy himself in a mountain solitude remote from the habitations of mankind. When all is still in the neighbouring plain, the wind here often blows violently, and is deflected from cliff to cliff with a sound which, to the mind of a contemplative geologist, might suggest the idea of audible spectres of stormy billows which once may have followed the same course, as they rebounded from side to side of a narrow inlet of the sea. During the writer's first visit to this spot, numbers of rooks were soaring from precipice to precipice, and often appeared like black dots against a narrow strip of sky; while the resemblance to white ants presented by sheep browsing on ledges near the top of the cliffs furnished a much more impressive idea of their height than any process of measurement.

Some of the old women, who importunately press their services on the tourist as guides, will tell him that the Wind Cliff is 480 feet high. This cliff (to which no drawing can do justice) is certainly a most remarkable specimen of a literally mural precipice of considerable breadth, and at least 300 feet in height. It is *quite* perpendicular from top to bottom, excepting where it overhangs. It is a much finer and larger face of rock than the cliff at the entrance to Goredale in Craven, Yorkshire, and nearly twice the height of the rocky part of the High Tor, near Matlock, in Derbyshire. As regards continuous perpendicularity, I believe it is not equalled by any limestone cliff in the kingdom. Next to the Wind Cliff, the so-called Cathedral Rocks are the most impressive. They consist of several buttresses projecting forward from the main line of cliffs. Their sides are perpendicular, and their fronts overhanging. The height of the summit of one of these rocks above the level of the road at the bottom of the ravine has lately been ascertained to be about 420 feet. The way in

which it was measured is deserving of notice. A worthy scientific gentleman of the neighbourhood ventured to crawl on to the summit from the grass-covered down behind, until he found himself on the brink of three precipices—those on the right and left perpendicular, the one in front overhanging. He dropped a line from the most extreme part of the brink, which went down without touching rock until the plummit struck a slightly-projecting terrace near the bottom of the ravine, and then fell on the road. There is probably no other part of England where a conformation of cliff-architecture would admit of a similar feat being accomplished. But our wonder at the cool intrepidity of the performer will not be so great when we consider that he was a member of the Society of Friends.

It has already been hinted that the Cheddar ravine is very tortuous. It consists of an alternating series of recesses and projections, or small bays and headlands. In some places there is a certain degree of correspondence between the hollows on one side and the protuberances on the other, which might at first lead one to fancy that the ravine is solely or mainly the result of a violent severance of the rocks; but a little observation will be sufficient to show that the two sides were never in contact. On the right, looking from Cheddar, the cliffs are very precipitous; on the left, they generally slope down into the ravine at a small angle.

The cliffs mainly consist of large faces of moss-covered rock, but the clefts and narrow terraces furnish a habitat for various plants, which add beauty to the sublimity of the scenery. Ivy and yew grow out of the fissures, and in various places may be found liverwort, polypody, meadow-rue, crimson mountain-pink, etc. The "screes"* at the bases of the cliffs have in many places acquired a covering of grass, and do not now appear to be in course of accumulation. The positions they occupy in some places would seem to indicate that they must have been thrown up against a wall of rock, or into a recess, rather than hurled down from above. The effects of the action of frost and rain, however, may be seen in favourable situations. The frost detaches angular fragments from incoherent parts of the cliffs, and from the under sides of rocky projections. The rain carries previously-detached fragments and chips down the "rakes," or vertical passages which indent the face of the cliffs. Vegetable mould and red loam are likewise washed down by rain from the top of the cliffs, and subjacent fissures. Nearly the whole surface of the Mendip Hills is covered with red loam, which fills up the fissures, and, to a certain extent, the caverns. Its derivation, and period or

* A convenient name used in the Lake district for the accumulated wrecks of cliffs and declivities.

periods of deposition are involved in mystery; but it seems to be generally admitted that it must have been a kind of sea-ooze left by retiring waters during one or more submergences of the land. In later times, it has been re-arranged by sub-aerial and subterranean fresh-water streams.

The Cheddar caves are regarded by the natives as the greatest source of attraction. One, in particular, has become very celebrated for its stalactites. But as it is probably surpassed in this respect by caves in Derbyshire and elsewhere, the main attraction of the Cheddar ravine must ever lie in the almost unparalleled grandeur of its cliff scenery. In this ravine there are many caves, little known and seldom visited, which present phenomena more interesting to the geologist than stalactitic concretions, however much the latter may resemble any earthly or unearthly objects the guide or the visitor may fancy. On the left side, walking from Cheddar, before reaching the Strait, there is a cave with a very conspicuous entrance at some height above the road. It has apparently been scooped out, or at least enlarged, by an inwardly-directed agent, such as sea waves, and not by an out-flowing fresh-water stream. On the right side, at various altitudes, there are many caves. In nearly all of them the roof is more or less rounded, and the sides here and there smoothly hollowed out into pot-shaped cavities. In short, the interior of these caves display obvious signs of the action of water, charged with a sufficient amount of solid matter to enable it to round and smooth limestone rock; and the position in which the rounded and smoothed surfaces often occur, would seem to point to the action of powerful waves as the only adequate explanation. It is true that fresh-water percolates through crevices in limestone districts, and the Cheddar brook has its visible source in several streams which flow out of subterranean cavities near the south-west end of the ravine; but it is not very difficult for one who is familiar with the peculiar forms resulting from the inward and upward gyratory action of the waves of the sea to distinguish these forms from marks left by fresh-water streams. The latter tend to wear their channels downwards, and can never produce smooth vaulted roofs, hanging or inverted pot-holes, arched entrances, and other characteristics of sea-worn caverns.

Mr. W. Boyd Dawkins (to whom the scientific world is so much indebted for the exploration of Wookey Hole Cavern, a few miles from Cheddar*), believes that the Cheddar ravine is an immense unroofed cave, the abstraction of the rocks once filling the now vacant space having been effected by atmo-

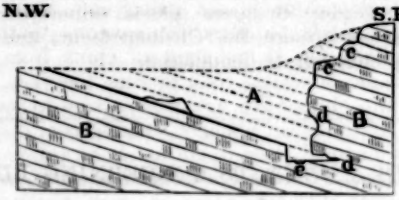
* See first paper on Wookey Hole, in the "Quarterly Journal of the Geological Society."

spheric agency. It is true that rain-water, especially when assisted by *humus* derived from the vegetable soil above, is capable of enlarging crevices. But the erosion resulting from its chemical action is limited to spaces where stalactitic and stalagmitic deposition is not going on. This deposition evidently rather tends to preserve caverns than facilitate their destruction. The detachment of chips from rocks by frost in favourable situations is a process likewise limited to spaces where the chips have not accumulated to too great an extent. All atmospheric agencies which can only remove matter a short distance must tend to choke up or glut their sphere of action. Without the assistance of a powerful transporting agent they can never, in such situations as the Cheddar ravine and its caves, make permanent progress in the great work of denudation. But supposing atmospheric action during millions and millions of years to be capable of producing a vacuity as large as the Cheddar ravine, its *form* would still remain to be explained. Sufficient time allowed, a colony of ants might be considered capable of rearing a mountain mass equal to the Alps, but an examination of the form of the Alps would at once forbid the idea of insects having been the architects. Atmospheric agents, whether operating above or under ground, are now producing nothing similar in form to the main features presented by the Cheddar ravine. That the cliffs have been modified in exposed situations by frost is evident, but the modification has been in the direction of *destroying* and not developing the characteristic forms of the cliffs. The same remark applies more or less to the action of fresh-water in caves.

The common notion that the Cheddar ravine is a crack or rent may, in a very limited sense, be correct. It is possible, if not probable, that at first there may have been a narrow winding fracture similar to that behind the High Tor at Matlock. It is, however, certain that no fracture ever occurred sufficient to disturb the angle at which the strata dip in a south-easterly direction, which on both sides of the ravine exactly corresponds. A very little observation will be sufficient to convince any one that the ravine has been mainly, if not entirely produced by the *abstraction* of an immense mass of limestone rock. The following diagram will show the stratigraphical structure of the locality, the dotted lines representing the strata which have been removed.

From the foregoing observations I think it must appear obvious that the *clean removal* of a stupendous quantity of rock must form the burden of any satisfactory explanation of the origin of the Cheddar Cliffs. It is true that in some places the rocks are now crumbling, but there is no agent (with the

exception of man) to carry the detritus away. In most places the rocks have preserved their original smoothness and regularity of outline. Here and there concave undercuts run hori-



Section of Cheddar Ravine.—A, rocks removed; BB, remaining rocks; cc, terraces; dd, undercuts; e, road.

zontally along the the faces of cliffs, while at the base of others there are cavernous recesses with water-worn roofs. But the most instructive forms of rock surface are the planes caused by jointing and bedding. They show that the mode in which the adjacent blocks or masses were carried away was not a process of granular dissolution, nor even fragmentary dilapidation, but a bodily displacement. The cause must have been equivalent to the translation of large blocks of limestone. To borrow an illustration from the well-known cheese of the neighbouring plain of Cheddar, if a farmer were to find one morning that a part of a cheese was missing, and that the surface left was smooth and regular, he would conclude that some person had cut a slice with a knife, not that a mouse had been nibbling at the cheese during the night; or, suppose the farmer were to find that a whole cheese had been removed from his store-room, he would at once conclude that a power capable of carrying it away in a lump had been concerned in the theft. A puny agency, which carries on its work grain by grain, or bit by bit, cannot leave a smooth, plain, and regular surface of any extent; but a violent and powerful agency, while it is not incapable of leaving a rough surface (circumstances being favourable), mainly tends to produce breadth and uniformity of contour.

The most philosophical way of trying to explain natural phenomena is to seek for similar phenomena now in course of being produced; and many modern sea-coasts exhibit fac-similes of the Cheddar cliffs. The forms of these cliffs are precisely those which would result from waves driven by storms into a narrow inlet of the sea. At a greater elevation, near the summit of the Mendip hills, smoothed (sometimes polished), rounded, hollowed, perforated, and grooved surfaces of rocks may here and there be traced. The way in which they have been shaped

may be seen on the neighbouring sea-coast at the present day. At a little lower level than the Cheddar ravine there are generally-acknowledged indications (such as sea-shells*) of the sea having once covered the plain between the Mendip range and Polden Hill. During the great glacial submergence the sea may have washed through the Cheddar ravine, and completed, if not entirely effected, its denudation.

DOUBTS AND FACTS CONCERNING LINNÉ.

THE progress of investigation into the evidence of recent changes in the lunar crater Linné has cast considerable doubt upon the opinions so positively expressed by Schmidt, and accepted by most astronomers. In order to place the question as fairly as possible before our readers, we now publish a short paper by Mr. Birt, F.R.A.S., and some extracts from an important communication just made by Mr. Huggins to the Astronomical Society, and published in the "Monthly Notices;" and also a letter from the astronomer Wolf, recently read before the French Academy.

THE NEW CRATER ON LINNÉ.

BY W. R. BIRT, F.R.A.S.

The question of change on the moon's surface, supposed to have been manifested in the case of the crater Linné, with which our readers are acquainted, remains *undecided*. Respighi, on the Continent, as well as several eminent astronomers in our own country, having come to the conclusion that no change whatever has taken place in the condition of Linné, and that if any appearances have been presented indicating change, such appearances are to be explained either by defective observations, by unfavourable conditions of our own atmosphere, by variations in the angles under which we see lunar objects, or by different incidences of the solar light falling upon them. There can be no doubt that each of these circumstances materially affects the *appearances* of lunar objects, and it is the more important in the instance which is now exciting considerable attention, to *know* more fully the *facts* rather than to rest on the conclusions that may have been drawn from a partial examination of facts presented, it may be, by a single series of observations.

* At Burtle, in the marshes of the river Brue, there are sand-banks full of marine shells, which are believed to indicate a comparatively recent and partial submergence of the land.

The results that have as yet been arrived at, and which are supported both by English and Continental observations, are as follows :—

First. The existence of a *shallow* crater, usually presenting the appearance of a whitish cloud, which, by the way, is of variable size; the crater itself has been very rarely seen. Respighi saw it on the 10th of May, 1867, during a perfectly tranquil state of the air. Knott caught a sight of the ring on January 12th, 1867, and, on the same evening, in moments of quiet air and good definition, Buckingham noticed the shallow depression. Webb saw the ring on April 11th, 1867.

Second. In this shallow crater or depression, a little west of the centre, a small crater with a well-marked interior shadow has been seen more or less distinctly, both in England and on the Continent, since November, 1866; in some cases as a perfect crater, in others portions only have been detected. The evidence tending to establish the existence of this small crater is certainly beyond dispute.

Third. Herr Schmidt, of Athens, carefully observed Linné from October 16th, 1866, and during November, 1866, without having detected either the large *shallow* crater or the small one within it. The rim of the small crater appears to have first arrested his attention on December 13th, 1866, as a delicate white hill; Buckingham seems to have first seen the shadow as a black spot on the following evening, December 14th.

In all former records of Linné nothing is said of *two* craters, *one within the other*. Linné is simply described as a crater.

In the older records the diameter of Linné is given by one authority (Schmidt) as 1·5 German miles, and by another (Beer and Mädler) as 1·4 German miles.

Since December 14th, 1866, the diameter of the white cloudy mass has been measured *nine* times. Schmidt has given *two* estimates of its extent, October 18th, 1866, at 2 German miles, and December 27th at 2000 toises only.

Three estimations of the size of the small crater have been given; the first, 1867, February 11th, by Secchi, at most $\frac{1}{4}$ of a second. The second, some time in April or May, 1867, by Respighi, viz., 4 seconds. The third, by Wolf, 1867, June 12, at 1 second. These estimations differ very considerably the one from the other.

In cases of measurement the values were obtained in seconds of arc. The estimations were in German miles, or toises.

As the value in miles, or English feet, of a second of arc at the moon's apparent centre increases as the object is removed from the moon's centre in the proportion of the secant of the angular distance from the centre, it is easy to

find the value in seconds of arc of the estimations on the one hand, and in English feet of the measures on the other. From the data given, the following table has been constructed:—

ESTIMATIONS AND MEASURES OF THE EXTENT OF LINNÉ.

Authority.	Epoch.	Eng. feet.	"	Objects.	Remarks.
Schmidt		36,449	5·17	Crater	
B. and M....	1831	33,482	4·83	Crater	
Schmidt	1866, Oct. 18	48,688	6·90	Whitish cloud	
Birt	1866, Dec. 15	81,920	11·61	Whitish cloud	Measured
"	1866, " 18	49,886	7·07	Whitish cloud	Measured
"	1866, " 19	51,650	7·32	Whitish cloud	Measured
"	1866, " 21	47,627	6·75	Whitish cloud	Measured
Schmidt	1866, " 27	12,790	1·81	Whitish cloud	
Birt	1867, Jan. 14	56,100	7·95	Whitish cloud	Measured
Buckingham	1867, Mar. 14	42,336	6·00	Whitish cloud	Measured
Wolf	1867, June 12	31,752	4·50	Whitish cloud	
Birt	1867, July 8	37,623	5·33	Whitish cloud	Measured
"	1867, " 9	49,420	7·00	Whitish cloud	Measured
"	1867, " 10	37,845	5·36	Whitish cloud	Measured
Schmidt	1866, Dec. 13	1918·4	0·27	Delicate hill	
"	1866, " 26	1695	0·24	Fine black point	
"	1867, Jan. 25	1279	0·18	Fine black point	
"	1867, " 25	1918·4	0·27	Fine white peak	
Secchi	1867, Feb. 11	2352	0·33	Small crater	
Respighi	1867, Apr., May	28,224	4·00	Small crater	
Wolf	1867, June 12	7056	1·00	Small crater	

This table furnishes three sets of numbers: first, the diameter of the crater in 1831, and about that epoch; second, the estimations and measures of the whitish cloud, in which there are considerable variations; and third, the estimations of the small crater. Under this head the most serious difference is that between Secchi and Respighi.

It would be highly improper to question for a moment the estimation of Respighi. The difference, however, between his estimation and that of Secchi, of nearly 26,000 English feet, calls for some remark. Respighi's observations were made with great care, and it is probable that he might have seen an opening which he estimated at that diameter, especially as the small crater was seen with greater distinctness in April. The diameter of this opening may, from some cause or other, not have been permanent in its extent. I am quite satisfied, that with the Royal Society's refractor of 4½ in. aperture (Respighi's was 4½ French inches aperture) I could have seen and measured a crater of 4″·0 in diameter; in fact, I have many smaller on the British Association outline map, which I have not only seen, but discovered with the 4½ inch aperture, power

230. I have records of observations made on April 11 and May 11, 1867, in which I expressly state that *I could not detect any object on the surface of Linné.* With Mr. Barnes' silvered glass reflector (*With*) I very carefully examined Linné, on the 10th of June, 1867; but although both Mr. Barnes and Mr. Browning saw a white nucleus, I was unable to detect it, and saw nothing of a crater of the magnitude of 4″·0, which I think I must have seen, had it been there.

With regard to the variations in the extent of the whitish cloud, I have observed phenomena of the same kind on the Mare Crisium, and about seventy sets of measures of Dionysius, yield the same result, though not to so great an extent as in the case of Linné.

OBSERVATIONS ON LINNÉ.

BY WM. HUGGINS, ESQ., F.R.S.

In "Monthly Notices" Mr. Huggins publishes a view of Linné, as seen by him on May 11, at 8h. 45m. It represents Linné as an oval white spot, and to the west of its centre shows a white ring surrounding a black spot. Mr. Huggins remarks, "At the time when the diagram was made, the shallow, saucer-like form of Linné was not seen; but I have detected it on other occasions. June 8, at 7h., when a great part of the light reflected from our atmosphere was removed by means of a Nicol's prism, I observed a shadow within the eastern margin of this shallow crater. When the diagram was taken, on May 11, the "interior of the small crater was in shadow, with the exception of a small part of it towards the east. The margin of the small crater was much brighter on the western side, and at this part appears to be more elevated above the surface of Linné. Under a very oblique illumination this high eastern wall appears as a small bright eminence, and casts a somewhat pointed shadow."

On the 9th July, at 9, Mr. Huggins measured Linné, and found the

Length of the bright spot	7″·85
Breadth	6″·14
Diameter of small crater	1″·71

The power employed was 500.

On the 14th Feb., 1866, Mr. Huggins examined the spectrum of the light from Linné, but could detect no lines not belonging to solar light.

Mr. Huggins quotes Schröter's description of Linné, and remarks that in Plate IX. of his "Selenotopographische Fragmente," "the place occupied by Linné is marked by

a round white spot, and not by the figure of a crater." Schröter's words are, "*Als ein weisses sehr kleines rundes Fleckchen erscheinende, etwas ungewisse einsenkung in sich hat;*" which may be translated, "Appearing as a white, very small round spot, with a somewhat uncertain depression in it." Mr. Huggins observes that such a description coincides very well with existing aspects, and he does not think the absence of any notice by Schröter of a small interior crater is of much weight in indicating its subsequent formation. He adds, that "Lohrmann's description and that of Mädler do not appear to be in accordance with Schröter's observations, or with the present condition of the object."

WOLF ON LINNÉ.

(*From "Comptes Rendus," June* 17, 1867).

Since the 10th May I have noticed that the crater Linné continues to exist, but with a much smaller diameter than that of the crater indicated in the maps of Lohrmann or Beer and Mädler. In the centre of the white spot a circular black hole may be seen, bordered on the west by a portion of ground which seems prominent above the remainder of the spot. This slight extra elevation has already been described by Schmidt. Atmospheric circumstances did not allow me to obtain an irreproachable image of the moon before the 10th June. On that day, at 8 o'clock, Linné had already been in full light nearly 48 hours, and the central hole could be seen with perfect sharpness. It is a deep crater—deeper than most of the little craters surrounding it, if one may judge from the comparative intensity of the shadows; but its diameter is not equal to that of craters A and B of Beer and Mädler. The white spot which spreads radiatingly (*s'étend en ragourant*) round it, had, on the 12th June, a diameter of 4″·5, that of Bessel being 7″·7. The crater itself subtending a little less than one second. The perfect purity of the atmosphere, and the optical power of the telescope (0m. 40) which I employed, allowed a number of small craters to be seen very distinctly round Linné, or rather a number of small round holes without elevated margins, and which are not shown in Beer and Mädler's map. Six of these little craters form a very remarkable double range to the north and north-east of Linné. They are smaller than the craters in a line situate to the north-west of Linné, and noticed by Schmidt. I employed magnifications of 235, 380, and 620 times.

The brightness of Linné has not changed since Beer and Mädler's observations, for it is always equal to that of the white spot situated near Littrow, on the western margin of

the Sea of Serenity, to which B. and M. assigned the luminosity 6.

If, then, we compare, the actual appearance of Linné with the *text* of Lohrmann and his successors, it is possible, *à la rigeur*, to believe that it has undergone a certain change. Linné has always been a deep crater, with elevated margins; its lustre has not changed—its total diameter has remained about the same. A comparison of *maps*, on the contrary, indicates a real alteration, for these figure a large crater occupying all the space now filled by the white spot. Schmidt thinks that we cannot refuse to attribute great weight to the identity of the indications of these two maps. The authors of the second, having the first at their disposal, it is probable that if they had not found the great crater drawn by Lohrmann, they would have noticed so extraordinary a fact. It is not, however, without interest to compare their indications with that of earlier maps. The picture drawn and presented by Lahire, which is in the library of St. Geneviève, represents Bessel, Sulpicius Gallus, and other little craters, equal to Linné in the map of Mädler; but he does not indicate Linné. He has only many white spots in this part of the sea. Cassini's map appears merely a copy of Lahire with less detail. According to Schmidt's note, Schröter seems not to have seen Linné,* at least not as one of the principal craters in the Sea of Serenity, although he noticed others that were smaller.

If we consult the photographs of the moon, we see, in the large copy of Warren De la Rue (1858), Bessel and Sulpicius Gallus exhibiting an indication of an interior shadow, while Linné figures as a white spot. The same is seen, though clearer, in the enlarged copy of the magnificent photograph obtained by Mr. Rutherford on the 4th March, 1865.

The disappearance of the great crater of Linné, then, dates as far back as 1858, if not as far back as Lahire. Apart from the indications supplied by the maps of Lohrmann and Beer and Mädler, to which we may oppose the counter indications of Lahire and Schröter, we only possess a single positive document testifying that Linné has undergone any change, and that is the affirmation of Schmidt that his crater and drawings of 1841 represent the object differently to what is now seen.

REMARKS OF ELIE DE BEAUMONT.

M. de Beaumont observed, when the paper was read to the French Academy, that if observers placed in the moon viewed Vesuvius or Etna before and after an eruption, they

* See Mr. Huggins's quotation from Schröter.

could only notice very slight changes. A great eruption even of Vesuvius would produce no other effect than to diminish slightly the depth of the semicircular trench of the Atrir del Cavallo, and to change its colour. Seen from the moon, such an alteration would appear problematical, and would give rise to discussions amongst observers. The observations made by P. Secchi on the 10th and 11th of February last ("Comptes Rendus," 25th February), tend materially to the belief that some change of this sort must have been produced in the configuration of the crater Linné, since the date of Lohrmann's and Beer and Mädler's maps. Moreover, it is to be desired that observations relating to the absolute permanence, or to very slight alterations on the moon's surface, should be multiplied, for a single change, however slight, would suffice to show that a geological life exists in the interior of the moon, as well as in the interior of the earth.

CURIOSITIES OF SOUND.*

PROFESSOR TYNDALL'S lectures on sound are, in their way, as admirable as the lectures on heat, which formed the foundation of his well-known work, "Heat as a Mode of Motion," though in dealing with the aerial vibrations which act upon our auditory nerves he has chiefly had to expound the discoveries of others, while in discussing the phenomena of heat it was his happy task to record many brilliant discoveries of his own. We are very glad that he has used plain English on his title-page; a book on "Sound" promises to be intelligible and interesting, while a treatise on acoustics would look alarming and dry. All through the work before us we meet with indications of the learned professor's remarkable aptitude for presenting his subject in a simple and elegant form, and it is gratifying to be assured that the present book will do far more than has been accomplished by any preceding publication to popularize a branch of science that has suffered much neglect, from the erroneous impression that it was too abstruse for ordinary minds.

A world without sound would seem a dismal solitude to those who are familiar with human voices, the notes of birds, the cries of animals, the hum of insects, and the multitudinous noises of active life. What we call the silence of night and of waste places, and which, for a brief period, yields the

* "Sound:" a Course of Eight Lectures, delivered at the Royal Institution of Great Britain, by John Tyndall, LL.D., F.R.S., Professor of Natural Philosophy in the Royal Institution, and in the Royal School of Mines. Longmans.

sensation of calmness and repose, is not as soundless as we imagine; but even that would be oppressive if endured for long; and could we visit a planet without an atmosphere such as our moon is supposed to be, how appalling would be the dreariness of its great mountain shadows, throwing their huge black pall over the scene, as the sun deserted vast regions of crags and plains, in which not the faintest whisper of any voice was heard.

We have in several previous papers explained the nature of *waves*, and their propagation. Sound is the result of *vibrations*, or wave-movements, transmitted by the air to the delicate apparatus of our ears, and then reaching our brains, where they become transformed into *sensations*, of which the mind takes note. In wave-motion the particles of matter first affected vibrate or oscillate through small spaces, but they communicate their own motion to other particles; and so the *wave-form* spreads and spreads, until it becomes too feeble to be discerned. A stone thrown in a pond illustrates these actions. Circle after circle of ripples are formed, wider and wider, but shallower and shallower, until they are stopped by the banks; or, if the pond be big enough, until, in acquiring great *width*, they have lost so much *depth*, that they can no longer be seen. Further illustration of wave-propagation, as a series of spherical shells, will be found in the paper referred to; and though the subject may appear a little difficult at first sight, it will prove very simple when approached step by step.*

If we have an instrument capable of communicating strong vibrations to the air, such as a bell, and place it under the receiver of an air-pump, and strike it while in that position, we shall have a full sound while the receiver contains its ordinary quantity of air; but keep the bell ringing, and at the same time pump the air out, the bell sounds will grow weaker and weaker, until at last, if we make the vacuum sufficiently complete, they will no longer be heard at all. The intensity of a sound in a given medium depends on the force with which its particles are moved, or on the velocity of their motion. "Fix your attention," says Professor Tyndall, "upon a particle of air as a sound-wave passes over it; it is urged from its position of rest towards a neighbouring particle, first with an accelerated motion, and then with a retarded one. The force which first urges it is opposed by the elastic force of the air, which finally stops the particle, and causes it to recoil. At a certain point of its excursion, the velocity of the particle is at its maximum. *The intensity of the sound is proportioned to the square of this maximum velocity.*"

The intensity of a sound is, as we have seen from the air-

* See "Radiant Forces," INTELLECTUAL OBSERVER, March, 1867.

pump and bell experiment, also dependent upon the density of the air in which it is generated, growing feebler as that density is reduced. Professor Tyndall says, "Supposing the summit of Mont Blanc to be equally distant from the top of the Aiguille Verte and the Bridge of Chamouni, and supposing two observers stationed, the one upon the bridge, and the other upon the Aiguille, the sound of a cannon fired on Mont Blanc would reach both observers with the same intensity, though in the one case the sound would pursue its way through the rare air above, while in the other it would descend through the rare air below." If the cannon were fired in the dense air of the bridge, its sound would reach the top of the mountain; while if fired in the thin air of the mountain-top, it might be too weak to be heard below.

Sound grows weaker by spreading. When strong vibrations act upon a small number of air particles, they throw them into violent commotion; but when the same amount of force operates on a much larger quantity of air, the movement of each particle is less rapid, and the sound declines. By speaking through pipes we check the lateral propagation of the sound-wave, and hence the voice can be heard at great distances; and it is easy, by means of apparatus now common in large places of business, to hold conversations with persons in any part of extensive premises. It is a curious instance of the force foolishly allowed to conventional habits, that this mode of communication is not applied in ordinary domestic life. It would be more rational for the parlour to adopt this quick mode of conveying its orders to the kitchen, than to ring bells to summon domestics to hear what is wanted, and then go and fetch it—a proceeding involving a waste of labour and a loss of time. Barbaric ideas of grandeur always include waste; but as civilization advances, it will be seen that the most dignified thing is to act in the most rational way, and to accomplish desirable objects with the greatest economy of any sort of force.

Sound may be readily deadened by the interposition of non-elastic bodies. It would be difficult to talk through a feather bed, though easy to be heard through the wainscot panelling of a room.

Sound is capable of being reflected like light. Echoes are the result of natural or artificial arrangements, which send the waves back again, as many times as the echo repeats, and by interposing a balloon filled with carbonic acid in the way of sound-waves, they may be bent out of their diverging course, and concentrated just as a spherical lens concentrates beams of light. A parabolic reflector will send the rays of a lamp in a long narrow divergent cone for many miles across

the sea, and if a speaker or singer were placed in such an apparatus, his voice might be heard at great distances by persons situated within the boundaries of the cone.

The velocity of sound propagated through air at the freezing temperature is 1089 feet per second, and at 26.6° Cent., or 78.8° F., 1140 feet.* If the *elasticity* remains the same, augmentation of the density of air or gas diminishes the velocity of sounds. Hydrogen gas, which is as elastic as air, and much lighter, is consequently more favourable to the rapid transmission of sonorous effects.

At the freezing temperature, hydrogen transmits sound at the rate of 4164 feet per second, or nearly four times as fast as air, while carbonic acid does so at the much lower rate of 858 feet per second. Water conducts sound with more than four times the velocity of air; pine wood, *along its fibres*, ten times as fast; and iron, seventeen times as fast.

The elasticity of air is increased by raising its temperature, and as air opposes a certain resistance to the passage of a sound-wave, its temperature is actually raised a little by its stoppage of a quantity of motion, and its conversion into heat. From this cause air conducts sound a little quicker than was originally calculated by Newton, who did not take into account this curious cause of its change of temperature.

The ear is pleased with the regular recurrence of impulses, and with the succession of sounds, or their combination, according to certain principles of proportion. Noises as distinguished from musical sounds are wanting in regularity, and discords lack the desired proportions. All sounds consist in a series of pulsations, and if they are to form musical notes, they must be quick enough to give the sense of continuity to the ear, and not too quick to be audible—a matter explained in a former paper, which we published, entitled, "Sounds we Cannot Hear."† Sounds may be too deep for a particular human ear, or for any human ear, and they may be too shrill. It is only a small part of the entire music of nature that we can hear, but our range is fortunately considerable, being from 16 to 38,000 vibrations in a second. The lowest notes are, however, imperfect, and do not sound well alone, and the highest are above those used in orchestral compositions, the practical range being comprised between 40 and 4000 vibrations in a second.

* The relation of the velocity of sound to the elasticity and density of the air, or other medium, is thus expressed:—"The velocity is *directly* proportional to the square root of the elasticity of the air, and *inversely* proportional to the square root of the density of the air."

† Vol. viii. p. 413.

The transmission of musical sounds through solids received some beautiful illustrations in Professor Tyndall's lectures. The following passage shows one of the magical effects which he produced:—

"In a room underneath this," said the lecturer, "and separated from it by two floors, is a piano. Through the two floors passes a tin tube two and a half inches in diameter, and along the axis of this tube passes a rod of deal, the end of which emerges from the floor in front of the lecture table. The rod is clasped by india-rubber bands, which entirely close the tin tube. The lower rod rests upon the soundboard of the piano, its upper end being exposed before you. An artist is at this moment engaged at the instrument, but you hear no sound. I place this violin upon the end of the rod; the violin becomes instantly musical, not however, with the vibrations of its own strings, but with those of the piano. I remove the violin, the sound ceases. I put in its place a guitar, and the music revives."

A harp was rendered musical in the same way, and as Professor Tyndall says, an uneducated person might well believe that witchcraft was concerned in the production of such music.

The vibrations of columns of air of various lengths give rise to the notes of organs and wind instruments, while pianos, violins, etc., are an illustration of the operation of vibrating strings, the sound of which would be feeble if it were not reinforced by the elastic wood introduced into the structure of such instruments.

Long strings vibrate more slowly than short ones, and thick ones than thin. If a whole string vibrates with a given velocity, half of it will vibrate twice as quickly, a third three times, and so on.

Strings, or air columns may vibrate as *wholes*, or may divide themselves into a number of equal parts, each one of which vibrates as if it were a whole; but when strings vibrate as *wholes*, they vibrate more or less in subdivisions at the same time, and hence arise *harmonic notes*, higher than the fundamental, or whole string, note. Different sorts of instruments tuned to produce the same fundamental notes, will add to them different harmonics, and thus be characterized by distinct qualities of tone, *timbres*, as the French call them.

The vibration of a string being compounded of whole length vibrations, and of the harmonic, or part length vibrations, just explained, there will be certain places at which the two sets interfere and produce *nodes*, or points of comparative (but not complete) rest; and Dr. Thomas Young discovered that when a string is plucked at any point, and caused to

vibrate, "all the higher tones which require that point to form a node, vanish from the clang."

To illustrate these facts, Professor Tyndall used an apparatus which our readers can easily imitate. He had before him a single chord instrument, with a scale divided into a hundred equal parts. By plucking the string at any division, and touching it (damping it) at any division, he was able to produce a number of easily-repeated effects. Plucking the string at 50, he said, "and now I affirm that the first over-tone, which corresponds to a division of the string into two vibratory parts, is absent from the clang. If it were present the damping of the point 50 would not interfere with it, for this point would be its node. I now damp the point 50; the fundamental tone is quenched, and no octave of that tone is heard. Along with its octave, its whole progeny of over-tones, with rates of vibration four times, six times, eight times—all even numbers of times—the rate of the fundamental tone disappears from the clang. . . . . I now pluck some other point, say 25, and damp 50 as before. The fundamental tone is gone, but its octave, clear and full, rings in your ears." In fact, by damping the string at 50 he made a node there, and it vibrated as two half-length strings, yielding the octave above the whole length.

The nodal points spoken of may be made visible by several contrivances: thus, when a string is employed, little riders of paper will keep their places where such points occur, and will be thrown off in other positions. By employing a square plate of glass fixed to a stand by its centre, and sprinkling fine sand over the surface, very beautiful figures, known from their discoverer as Chladni's figures, may be made, the sand being first agitated, and then resting in nodal lines. The plate is vibrated by a fiddle-bow, and damped by touching it at certain points with a moistened finger. Very beautiful and intricate patterns may be obtained in this way.

Musical effects depend very much upon *resonance*, or the reinforcement of a feeble sound, by enabling it to associate other and sympathetic vibrations with its own. Thus, a tuning-fork produces a feeble note alone, but when it is able to set another body or mass of air in vibration the sound becomes loud. An experiment referred to by Professor Tyndall is easily made. A tuning-fork is sounded over a tall narrow jar, and water gradually poured in until the air column in the jar is reduced to the length which gives the greatest resonance, when the sound is much louder. Pouring in more water diminishes it, by making the air column too short; the maximum effect being produced when the air column is one-fourth of the length of the sound-wave produced by the fork. An open tube gives a

maximum of resonance when twice the length of a closed one. The strengthening by resonance of feeble sounds not previously heard or noticed, is the cause of the "sea music," which children are so fond of when cowry shells are held to their ears. Caves and rocks resound to the noise of waterfalls, and deep wells to the fall of objects on the water which they contain.

Amongst the most beautiful and curious of the strange ways of sound, we must allude to singing and to sensitive flames. If a glass or metal tube, two or three feet long, is held at a proper height—easily found by trial—over a small jet of gas, a musical note is heard; and if the experiment is made on a large scale, the sound is violent. The musical note arises from a series of impulses communicated by the flame, which is a rapidly twinkling one, to the air. Hydrogen gas answers for these experiments better than coal gas.

The sensitive naked flames are the most extraordinary and apparently magical things. A broad fish-tail flame exhibits the phenomena to a considerable extent. Such a flame will jump and put forth tongues in sympathetic response to a particular set of vibrations. Professor Tyndall showed that, by producing a slight flutter with a blowpipe in a candle-flame, it was made sensitive, and jumped when a whistle was sounded. By adding to the pressure, and obtaining flaring flames from common fish-tail and bat's-wing burners, they became sensitive to whistles, and put forth curious tongues; and striking a distant anvil with a hammer gave similar results. By using a single orifice burner and suitable pressure, flames eighteen inches long were obtained, smoking copiously, and remarkably sensitive to sound vibrations of the right quality. By sounding a whistle, Professor Tyndall caused the flames to change instantly, and become short, forked, and brilliant. Another flame exhibited by the professor to his wonderstruck audience was twenty-four inches long, and by the slightest tap on a distant anvil it was reduced to seven inches. Dropping sixpence from the hand twenty yards off was sufficient to knock the flame down; the creaking of boots, the rustle of a lady's dress, the patter of rain, and the tick of a watch—all influenced it in a striking way. When lines of poetry were recited, the flame nodded to some sounds, took no notice of others, and when the tones of the voice were most in sympathy with it, "its obeisance was profound."

Here we must leave Professor Tyndall and his most interesting book, intending, however, to take another opportunity of recurring to more of the "Curiosities of Sound," to whose wonders, we hope, the present pages may prove an introduction for those who love science in its recreative aspects and lighter moods.

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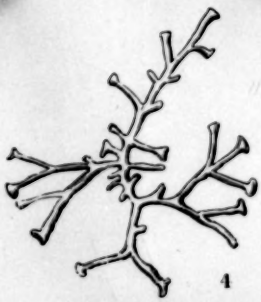

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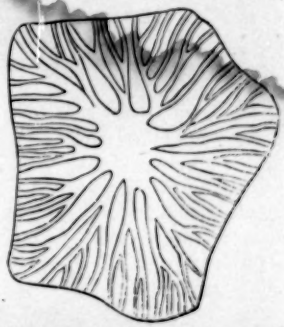

3

POTTERY TREE OF PARA.

THE POTTERY TREE OF PARA.

BY JOHN R. JACKSON.

(*With a Plate.*)

Amongst vegetable economic products the barks of various plants hold a prominent place, whether for medicinal, manufacturing, or other purposes. The structure and formation of all barks are more or less similar, though the contents of the cells vary much in different plants, thus we have soft or fibrous, hard or woody, and even stony barks, and the bark of the pottery tree of Para is a notable example of this latter. To outward appearance the formation of the bark in many plants would appear to bear no relation one with another, as, for instance, the cork of commerce compared with its near ally, the bark of the common oak, and again with the fibrous barks of many of our British trees. Naturally, the bark of a tree is, at first, composed of uniform cellular tissue, similar to the tissue of the central portion of the stem. The formation of the layers in the fully-developed bark is on the reverse system to that of the woody layers of the stem, the inner portion being the most vascular, and the outer portion the most cellular. Between the wood and the first formation of bark lies the cambium layer, a single series of nucleated cells, which originally are connected with both wood and bark, and perform certain functions in the formation of the woody fibres of the inner bark, and likewise in adding to the cells of the medullary rays of the wood. The innermost part of the bark next the wood, or rather next the cambium layer, is called the liber, or endophlæum; next to the liber, which is the fibrous part, the cellular part is placed, called the mesophlæum, or middle bark, and next that the epiphlæum, or outer bark. These three divisions are usually included under the general term of cortical layers. It is from the liber, or inner bark, which is composed of fibres more or less long and tenacious, that our most valuable commercial fibres are obtained.

In some plants the fibrous system prevails through the inner bark, but we shall have occasion to speak more fully upon these particular kinds at another time. What we have to deal with at present is a noted example of the harder, more woody, or more silicious barks, which example is to be found in the Para pottery tree. This is a large tree of very straight and slender growth, attaining a height of 100 feet before giving off any branches; the diameter of the base is seldom more than one foot, and rarely exceeds fifteen inches. The wood itself is very hard, and, as will be presently seen,

contains a great deal of flinty matter. The tree—which is called in Spanish El Caouto, or El Caouta; in French, Bois de Fer; in Brazil, Caraipe; and in English, pottery tree—is now known to botanists as the *Moquilea utilis, Hf.* Aublet was the first to bring the tree into notice, and it was at one time placed in the natural order *Ternstrœmiaceæ*, under the name of *Caraipa angustifolia*. Further information and research, however, has caused it to be placed where it now is. Sound and durable as the wood is, it is on the bark that the natives set the greatest value. The Indians employed in the manufacture of pottery from its bark always keep a stock of it in their huts for the purpose of drying or seasoning it, as it burns more freely, and the ashes are collected with greater ease than when it is fresh. For the manufacture of the pottery the ashes of the bark are powdered and mixed with clay, the purest clay that can be obtained from the beds of the rivers is preferred on account of its taking up a larger quantity of the bark ash, and producing a stronger kind of ware. The most valued bark, or that which contains the largest quantity of silex, is produced by trees which grow in a rich but dry soil. Those growing in low or sandy forests being much inferior in the quality of this deposit. In the best kinds the silex can readily be seen with the naked eye, but to test the quality of the various kinds of bark, the natives burn it and then try its strength between the fingers; if it breaks easily it is considered of little value, but if, on the contrary, it requires a pestle and mortar to break it, its quality is pronounced good. Though the proportions of ash and clay are varied at the will of the maker, and according to the quality of the bark, a superior kind of pottery is produced by mixing equal portions of fine clay and powdered ashes of the bark. All sorts of vessels of large or small size, for domestic or household use, are made of this kind of ware, as well as vases or ornamental articles, some of which are painted and glazed as in Fig. 6, which is a representation of a specimen in the Kew Museum. The figures upon this vase are not burnt in, but are merely superficial, the colour being laid on with a brush and secured by a coat of glaze. Fig. 5 is a representation of an unglazed pot, with lid, the figures of which are in relief. Articles made of this ware are very durable, and will bear almost any amount of heat; they are consequently much used by the natives for boiling eggs, heating milk, and, in short, for general culinary purposes.

Having shown the great value of this bark to the natives for a purpose which, to say the least, is novel in the application of barks, we will endeavour to arrive at the cause of such an adaptation by a brief exposition of its component parts.

The bark seldom grows more than half an inch thick, and is covered with a skin or epidermis frequently covered with lichens. A superficial examination shows nothing out of the common; the fresh bark, however, cuts somewhat similar to a soft sandstone, but, when dry, it is very brittle and flint-like, and sometimes difficult to break. By biting a piece of the bark the presence of silex can be well ascertained, as it grates between the teeth like fine sand. If we examine a section under the microscope, we find all the cells of the different tissues or layers are more or less silicated, the silex forming in the cells while the bark is very young. In the inner bark the silex or flint is deposited in a very regular manner, as will be seen by Fig. 1. The flint, however, from the ash of a porous cell of the bark assumes a very different appearance, as shown in Fig. 2. Fig. 3 shows a porous cell macerated, and Fig. 4 is a flint skeleton from a similar cell. The bark of young trees and branches contain a much larger quantity of water than that of old trees; the proportion of water, however, are more equal in the old and young woods. From an analysis made of both the old and young barks, the old was found to give 30.8 per cent. of ash, and the young bark 23.30. Of the different layers of the old bark, the outer gave 17.15 per cent., the middle 37.65, and the inner 31. A larger percentage of ash was yielded by the bark of an old branch, which was found to give 77. In comparison to the bark the wood is relatively poor in silex, the duramen, or old wood of an old trunk, giving only 2.5 per cent., and the alburnum, or young wood, 2 per cent. only.

The wood, bark, ash, and various specimens of the manufactured pottery, may be seen in the Kew Museum.

MARE VAPORUM AND THE LUNAR CLEFTS—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

WITH the object of comprehending in a continuous description the whole extent of the Lunar *Apennines*, our guides have carried us considerably beyond the 1st Meridian, and into the 2nd Quadrant of the Moon. They now bring us back towards the W. to complete the Quadrant with which they commenced, and introduce us to the *Mare Vaporum* (F in our map). This is a level surface, of a lighter tone than the other *Maria*, and possessing no very definite boundary, but lying in a general sense between the S.W. slope of the *Apennines* and the crater *Agrippa* (26). There would be little to make the region worthy of especial notice were it not that its S. part contains a full development of one of the most curious of the lunar features, the system of CLEFTS (or *Rills*). Fortunately for the telescopic observer, this district, while it lies in so central a position as to be very little affected by foreshortening, contains two of the largest and most obvious of these mysterious formations, "in which," say B. and M., "an attentive observation can recognize something more than their mere existence." Before we proceed, however, to describe them, it may be premised that there is a difficulty, not merely in comprehending their nature, but even in providing for them a suitable name. This arises from the fact that we are so little familiar with anything analogous to them on the surface of our own globe. It is true that features do exist, which, viewed at a corresponding distance, might have a somewhat similar aspect. We might refer to the transverse fractures of the Balkan range, and of some of the chains of Greece, the *Barrancas* of Mexico, or the marvellous *cañons* of the Colorado River (described in INT. OBS. iv. 309), which may, perhaps, exhibit as great a similarity to the clefts of our satellite as the terrestrial does to the lunar crater; and more could not in fairness be expected. But still, the fissures of our globe are too exceptional to constitute a system such as obtains on the moon, and consequently to have received any generally accepted name. Astronomers, therefore, are somewhat at a loss how to designate the lunar *crack*, if such it may be termed. Schr., the first discoverer of these objects, in 17·8, called them "canals," or "rills": the former term is obviously unsuitable to a dry surface, and has gone out of use; the latter has held its ground among the German observers, and very deservedly so, as far as their language is concerned, in which it signifies a small furrow, or

groove. Its adoption, however, by ourselves, though sanctioned by some great names, does not seem free from objection, on account of the existence of a similar, but by no means equivalent English word, the derivation of which, from the Latin, *rivulus*, and its meaning as given by Johnson, "a small brook, a little streamlet," refer unequivocally to the presence of water. It is, however, frequently easier to find a fault than to mend it; and in the present instance (*furrow* having been rejected, on high authority, as not sufficiently comprehensive), if the employment of the term *cleft* is suggested, it need only be looked upon as a provisional arrangement, till something more appropriate has been brought forward in its stead. It would indeed be a gain to selenography, if the whole subject of lunar terminology were to undergo a careful revision at the hands of those whose geological as well as astronomical acquirements would enable them to frame such a nomenclature as would command universal acceptance.

But, to proceed from the name, to the objects which it designates. The lunar clefts are characterized by B. and M. as very narrow and long depressions either in a straight or moderately curved direction; occasionally serpentine or hooked in form: with very steep,* parallel sides, and usually without any external rampart: in Full Moon they appear as delicate white lines; near the terminator usually as black ones, as we perceive only the shaded interior. They sometimes pass through or close by small craters, or come to an end in them; at others they lie isolated in level surfaces, without any marked termination; in fact, one of their frequent characteristics is this want of apparent object, as we might speak with reference to the handywork of intelligent beings. They are frequently hemmed in by mountains, but do not appear to run straight over them; occasionally they are found to unite like veins, and even to intersect one another. Their individual breadth varies but little; if there is any enlargement, it is somewhere in the middle, never at the end [rather an inattentive assertion, by the way]. They occur in every kind of surface, excepting on lofty summits, or in the centre of the great plains; being of course less distinguishable towards the limb. A few of them are only from 9 to 14 miles in length; the generality 45 to 70; some, again, reach a maximum of 115 to 140 m.: their breadth is in places not inconsiderable, a mile or upwards; but they may be traced down to ¼ of that size.† Connecting links with other formations may often be perceived: the enlargements occasionally noticed take the form of longish craters, or if these are frequent, the whole cleft appears almost like a chain

* Schmidt considers them not extremely steep.

† Schmidt gives their depth from 100 yards to ¼ mile.

of minute craters, with a lateral communication throughout: on the other hand, there are regions where contiguous mountains form, with their straight and parallel sides, gorges much resembling these clefts, and where long straight valleys are distinguished from them chiefly by their greater proportional breadth and inferior steepness; and several valleys of this kind are to be met with in the immediate neighbourhood of true clefts, and parallel to them. From these and other indications, such as their want of connection with any definite object, their occasional repetition in parallel lines within a small distance, and more especially their magnitude (as Schr. had already perceived), the idea of an artificial origin must be laid aside.

On this subject B. and M. have some remarks, which, though referring to speculations which have never found great favour among ourselves, are still worthy of consideration. They observe that, but from inattention to the scale of the objects we are studying, and from the unreasonable expectations entertained at the end of the last century of a marvellous increase of magnifying power (some persons, in Germany we may presume, seem to have been anticipating the use of powers of 15,000 !), the idea of these clefts being lines of road, or anything else of an artificial nature, would never have been seriously entertained.* In all such analogies, they judiciously remark, one very important point has been ignored—the relative proportion of gravity on the different bodies of the system. When this, as on the Moon, is $6\frac{3}{4}$ times inferior to that on the Earth, fresh relations are introduced between power, weight, and motion; and while we have no positive information as to artificial products on the Moon, it may be maintained with great probability that they would be totally unlike our own, and that, even if our optical means were capable of reaching them, they would not appear in any recognized or familiar form. Remarks of this kind are valuable if they check the vagaries of irrational fancy. We should take care, however, not to push them too far; it would be possible, though much less probable, to err in an opposite direction, and to impede the progress of discovery by an overweening estimate of our own previous conclusions.

The hypothesis of their being actually existing or dried-up water-courses may be disposed of with little trouble. All modern observers are agreed as to the absence of water, at least in any noticeable quantity, from the Moon as it now is; but could we conceive, with Gruithuisen, that it had formerly

* Gruithuisen referred them partly to dried river-beds, or natural clefts, partly to artificial clearings through forest lands, used in either case as lines of communication.

found a place there, the traces of its smaller receptacles would be of a very different character. The river-systems of a dried-up Earth, as contemplated from the Moon, would have a wholly dissimilar aspect, with their confluent branches, and their regular increase from end to end. The lunar cleft, on the contrary, often begins and ends on a high level, without ever reaching lower ground: or runs from mountain to mountain through a plain: it does not grow broader towards one end: it very seldom receives branches: it is very frequently straight: its proportional depth is too great, especially with the slight force of lunar gravity, to have been excavated by currents of water: it is often only ten or twelve times longer than it is broad: it frequently reappears on the further side of mountains which have interrupted it: or it keeps a regular curvature in passing through obstacles lying in every direction: occasionally it goes through craters of considerable size. All this—as well as the absence of any noticeable atmosphere—is inconsistent with the hypothesis of water-currents of any assignable date. The supposition of life in the Moon thus seems negatived. But why, ask our authorities, should we assume, as alone possible, the existence of that one form of life with which we are acquainted on our planet? Even with us the most extraordinary differences in climates and modes of life are found, co-existent with the same ultimate elements, with an uniform force of gravity, and an unvaried general density: why, then, should not entirely new arrangements as to life and motion have place under totally different conditions of existence in other worlds? To these very sensible questions, the spirit of which had been in many points anticipated by Schr., may be added some reflections of the latter to the effect that our speculations ought to be confined to what is deducible in the strictest sense from observation, and that there is no necessity that we should denominate the Moon "an entirely dry mass of chalk, and that therewith at the same time every substitute for water, so beneficial to us, should be denied to those who, as well as ourselves, are indebted to the Universal Father of nature for the enjoyment of an active life. With the largest telescopes we still see the great works of God always in a remote background, and can only keep ourselves to sure observations and their *immediate* consequences." He goes on to suggest (but in a very modest and rational manner) the possibility of some transparent fluid on the Moon, bearing an analogous proportion to her atmosphere, in point of density, to that existing between our water and air, and that it may perform a similar function in point of utility with regard to the needs of such organized life as may exist there. Till of late it might have been said that the analysis of aerolites, in the

composition of which no new chemical element has ever been detected, and from which we should infer a similarity of matter throughout the solar system, strongly contravenes such speculations. But the recent discoveries of Huggins, rendering it highly probable that the atmospheres of Jupiter and Saturn contain elements or combinations foreign to our knowledge, again restore the balance, and enable us to call the worthy old Hanoverian into court again. He always deserves at least a hearing.

Some other peculiarities of these clefts, pointed out by B. and M., in their "Beiträge," may be mentioned, as the result of their discovery, within six or seven years, of upwards of seventy, in addition to less than twenty previously known. Absolute straightness and singleness characterize the majority, and the average bearing falls between 8h. and 11h. of a clock-dial, divided into 24h. There is an optical cause why they should be frequently found in the line of the meridian, but scarcely ever in a 6h. (or E. and W.) direction, namely, the full development in the former, the absence in the latter case, of that internal shadow by which they are most readily distinguished. But no such reason will explain why more than fifty of them should be directed between 8h. and 11h., and only some thirty between 1h. and 4h. It is remarkable, however, that the prevailing direction of all lunar objects is so much the same that in some regions scarcely any other tendency is perceptible; that in the majority it predominates; and is absent from none; so that ridges alike and clefts seem to indicate a similar origin.

As to that origin, B. and M. consider it to have been due to a modification of the same eruptive force, the "reaction of the interior," as Humboldt would call it, which has so extensively modified the lunar surface. This would naturally press outwards along the line of least resistance, or, on the supposition of homogeneity of material, perpendicular to the surface; and during its earlier and intenser action would produce regularly circular cavities, or, if it encountered more coherent material, roundish mountains; as the activity decreased, and circumstances were changed by the great alteration of level, as well as of cohesive power, the direction of the force would be varied; it would take a horizontal course; and while in general it elevated the surface into those long ridges, or banks, of which instances are so abundant, it would occasionally burst it open, so as to form burrows or clefts. This speculation, which had been propounded by Schr. at a much earlier period, does not seem to commend itself by its plausibility. There is a difficulty in conceiving the continuous progress, perhaps for hundreds of miles, of an

elastic force burrowing "straight on end" like a mole under the ground, and, nine times out of ten, finding less resistance in its front than in any other direction; while, if such a ridge were subsequently to "cave," or drop in, it would leave no noticeable hollow. It seems more consistent with appearances to refer these clefts to the cracking and splitting, which would result from a contraction affecting the superficial more rapidly than the subjacent material. Such an explanation would not be without serious difficulties, from the very plastic condition of the surface which would be required, and the inconsistency of such a state with the sharpness and cleanness of earlier outbursts; still it may claim attention; but we are as yet too little advanced in the collection and comparison of facts to be able to form any very conclusive generalization. One thing is evident; that if we follow the example of Schmidt in including the Great Valley of the Alps in the catalogue, it is there that we shall find the most satisfactory test of our hypotheses, and that nothing can be admitted which fails to account for the production of that colossal gorge.

At any rate, B. and M. consider it certain that with, perhaps, a few exceptions, these clefts belong to the latest epoch of the lunar formations. Assuming the identity of their origin with that of the long low ridges, we may remark that it does not appear how this idea can be made to harmonize with the aspect of these latter, which in so many cases look like channels of communication contemporaneous with the formation of the more important mountains and craters; but there seem to be instances in which the posterior date of the clefts is capable of proof; and one such will shortly be laid before us. Considering it as well established that their general epoch is comparatively a modern one, these observers do not wholly deny the possibility of such processes being still in operation; and they admit that their opinion to the contrary, however strong, rests only upon the experience of seven or eight years.

The inquiry—a very curious one—has also been treated as an open question by a modern authority of great weight, Dr. J. F. J. Schmidt. This eminent astronomer has informed us, in his interesting memoir on the "Rills" of the Moon, that he has been occupied for twenty-five years in the study of lunar topography, during which he has made upwards of 1000 drawings and 3000 height-measures, without coming to any other conclusion than that no change of surface has recently taken place on any considerable scale; but that, as to the progressive multiplication of these minute clefts, he has by no means abandoned the idea of its possibility. He has succeeded in adding a great number to those already known; but this may

be readily accounted for, partly by his having made them more his especial study than B. and M. could do while occupied in a general selenography, and partly by the superior aperture of his telescope, and, still more, the charming purity of the Athenian sky, far transcending that of Berlin or even Rome. The value of his evidence may be understood from his principal instance, which relates to the region N.W. of *Aristarchus* (43). Here, 1862, May 10, with a power of 200 on his 8-in. dialyte (an instrument of inferior quality, from the decomposition of the glass), he detected no less than fifteen unknown clefts, some of considerable length and breadth, and not more difficult than many shown by Lohrmann and Mädler. He saw also, in the same neighbourhood, a group of new craters of no remarkable minuteness. Schr. had drawn this district six times; L. and M. must have done so eight or ten times, and under opposite illuminations. Schmidt himself had made twenty-one sketches and numberless observations, without perceiving these objects. On three evenings in 1836, M. drew the very spot, probably with the great $9\frac{6}{10}$-in. achromatic at Berlin; and while he inserted some smaller craters, omitted larger ones, as well as the clefts. In May, 1853, Schmidt had missed them all with the same instrument. All circumstances considered, if this is not wholly conclusive, we may look upon it as advancing a considerable way towards a conclusion. Schmidt's figure of this region gives high promise of the hitherto unpublished general Map of six (Paris) feet in diameter, which he is preparing solely from his own observations, and which we sincerely trust he may be permitted to complete. His catalogue of clefts gives 11 discovered by Schr., 75 by L., 55 by M., 6 by Kinau, and 278 by himself up to Feb. 1865—425 in all; a number which his diligence has probably since considerably increased.*

Having spent so much time in the general description of these curious objects, we must proceed to the complete and very instructive specimens referred to in the opening of our remarks; of which, and of the principal features of the neighbourhood, a diagram accompanies the present paper. It is copied from the Map of B. and M., omitting, however, a great accumulation of detail, and retaining only such features as serve our immediate purpose. The top coincides with the Lunar Equator. *Agrippa* and *Godin* will be easily identified

* One of those ascribed to Schr., the grand cleft in the *Alps*, was really discovered by Bianchini. Gruithuisen detected many, but has in general given very defective identification. Two of his, at least, are I think omitted in this list; and two if not three more might have been added which I noticed on the floor of *Atlas* with Mr. Bird's 12-in. silvered glass reflector, 1865, Sept. 7. I have also seen a bent cleft in the interior of *Furnerius* with a 5½-in. object glass.

LUNAR CLEFTS.

as 26 and 27 in our little Map; the remarkable crater *Manilius* (24) lies only a little below the area represented; for telescopic search these features, previously recognized from their position relative to the *M. Serenitatis* and the *Apennines*, will always be sure guides. The cleft passing through *Hyginus* is the first described by B. and M. It is conspicuous enough to be seen in a good telescope with a power of 40, and under almost any illumination. Its commencement, from the N.E., is at a long, low hill, and here it appears almost as a flat valley, nearly 1½ mile wide, but after a length of 9 miles it becomes narrowed to a breadth of 1300—1500 yards, with such steepness and depth that, in one instance, B. and M. distinctly perceived the delicate black line of shadow on one side running parallel with the brightly-illuminated opposite bank. In this part of its course, which is through level ground, it encounters four little craters, the second of which is 3200 yards, or nearly 2 miles across; the others 2000 to 2500 yards. After running about 50 miles it reaches the larger crater, *Hyginus*. But what happens to it there, and in its further progress, must be reserved to a future opportunity.

OCCULTATIONS.

Aug. 2nd, 22h. 34m. to 23h. 16m., or in common reckoning, 3rd, 10h. 34m. to 11h. 16m. A.M. the planet Mars. This obviously requires a large aperture and equatoreal mounting. —15th, e^1 Aquarii, 6 mag. 11h. 54m. to 12h. 52m.—16th, λ Aquarii, 4 mag. 7h. 50m. to 8h. 51m.

PHYSICAL GEOGRAPHY AS A POPULAR STUDY.*

Amongst the newly-cultivated branches of science, Physical Geography is one of the most generally interesting, because its broad facts and reasonings are easily appreciated, and no expensive apparatus is necessary for its pursuit. It ought to form a prominent subject in any national system of education; and when it is absent, school-teaching in what is called "geography," usually consists of little more than lists of latitudes and longitudes, courses of rivers, and positions of cities, separated from all associations that could give them the character of true knowledge. The simplest facts and problems of physical geography are eagerly apprehended by young children, when properly explained, while the complex considerations of terrestrial structure, and its influence upon temperature, climate, and civilization, tax the highest intellect, and furnish material for the profoundest thought.

During the last twenty years many excellent works on physical geography have been produced by various writers; but no one has appreciated more clearly than Professor Ansted the range of subjects that ought to be included, or the way in which they ought to be presented, so as to make the philosophy of the science intelligible as well as its facts. The advantage of a comprehensive scheme is very great, though it is necessarily associated with an unavoidable degree of incompleteness, when, as in the book before us, a variety of important matters are compressed within the limits of a few hundred pages.

Professor Ansted begins by considering "the Earth as a Planet," after which follows a chapter on "Physical Forces," succeeded by one on "the Succession of Rocks." These chapters are introductory, and it is in the second part that what is commonly understood as "Physical Geography" really commences. The distribution of land occupies three chapters; water, including ice phenomena, four chapters; four more are devoted to air, including winds and climate; igneous phenomena are treated in two chapters; and the work concludes with expositions of the broad features of terrestrial life. Any one of these subjects might be easily expanded into a treatise the size of the whole book; but there is an obvious advantage in presenting them in an epitomized form, and in the order which the Professor has adopted.

* "Physical Geography." By Professor D. T. Ansted, M.A., F.R.S., F.R.G.S., F.G.S., Honorary Fellow of King's College, London, and late Fellow of Jesus College, Cambridge, etc., etc. Wm. Allen & Co.

The size of the earth, its average density, the velocities of its diurnal rotation, and of its annual course, the size and weight of its satellite—these and similar facts belonging to astronomy, supply considerations which lie at the root of physical geography. We are continually, and, on the whole, equally affected by one class of astronomical facts, such as the recurrence of night and day, summer and winter, lunar action on the tides, and many others; while another class of astronomical facts relate to changes very slowly effected, and only producing important results after the lapse of long periods of time. We, or the people of any given generation, are of course most immediately influenced by the quickly-recurring changes; but, looking to the laws of succession and continuity, manifested throughout the operations of nature, it will be seen that our physical structure, our methods of life, and even our habits of thought, are, to a certain and large extent, the results of previous conditions of our planet, dating back even to its origin in the remote abysses of the past.

A very important consideration, well adduced by Professor Ansted, arises out of the astronomical fact that the eccentricity of the earth's orbit is the subject of secular changes. "When the eccentricity is greatest, the greatest distance of the sun from the earth may amount to 102,256,873 miles, and its nearest distance will then only be 87,503,039 miles, showing the very considerable difference of 14,753,834 miles, or more than one-seventh of the larger semi-diameter. This is a very important fact; for, as the amount of heat received from the sun varies as the square of the distance, it follows that the quantity of heat received in the former position, compared with that in the latter, will be as 19 to 26."

It will take twenty-four thousand years for the minimum of eccentricity to be reached, so that the change does not immediately concern the present inhabitants of the globe; but in past periods it may have materially affected the creatures then living upon it, and likewise produced modifications of form and climate, the influence of which has descended to our own times.

At present the earth comes nearest to the sun in winter; but "if, when the eccentricity is greatest, the case is reversed, the land of the northern hemisphere would be warmed only to the very minimum extent in winter, and heated to a maximum in summer, the difference would then equal one-fifth of the whole. There would then be far more extreme climates on the earth than there are now." In his "Outlines of Astronomy," Sir John Herschel, commenting on speculations of this nature, observes that about four thousand years before the Christian era, the place of the perihelion must have coincided with the

vernal equinox (or have been situated in long. 0°), and in long. 90° about A.D. 1250. In A.D. 11700, he adds that "the extreme summer and winter of the southern hemisphere will be transferred to the northern." Such changes must have taken place thousands of times in geological eras, and may have partially accounted for those changes of climate which geology and palæontology show to have occurred.

Terrestrial climate is still more strongly affected by the disposition of masses of land and water, the height and direction of mountain-chains, the character of the soil, its being covered with trees or left bare, etc. Of the whole surface of the earth "only a fourth part, or about fifty-two millions of square miles, rises above the uniform level of the water and form land," and it is remarkable that a great part of this land "is grouped round one hemisphere, so that not more than one twenty-seventh part has land opposed to it on the opposite hemisphere. Thus, if a person stationed vertically over Falmouth in England could see half the globe, he would see more than forty-nine out of the fifty-one millions of square miles of land, or about an equal surface of land and water. If, however, he were perched equally high above New Zealand, he would see ninety-six and a half millions of square miles of water, and less than two millions of square miles of land."

Any important change in the relative proportions and dispositions of land and water would materially modify the earth's climate. Supposing the quantity of each within a moderate number of miles from the surface to remain the same, but the shallow seas to be considerably deepened and at the same time narrowed, and the bulk of continuous continents very much augmented, there would be a diminution of evaporation, and an addition to excessive or continental climate. On the other hand, rendering deep seas shallower, and diminishing the area of land by a corresponding change in its level would produce opposite effects, and the violence of the alteration would depend partly on the average extent to which levels were modified, still more on the position of the high lands.

The laws which determine the relative disposition of land and water are very little known; and hence there is room for two opposite suppositions, according to one of which the present arrangement depends on permanent causes of very ancient date; and, according to the other, great changes may have taken place within comparatively moderate periods, and equally important alterations may still be going on, though their rate may be very slow. Professor Ansted refers to a speculation of Mr. James Yates, that the centre of gravity of the earth would not be coincident with the centre of magnitude without the protuberance of water on one side, and that the inequality of land

in the two hemispheres is permanent. We have not read the paper in which Mr. Yates put forward this ingenious speculation, but we doubt there being sufficient evidence to raise it above the level of a conjecture, and when we look to the action of aqueous, igneous, and aerial causes of modification, we are not disposed to attach very great importance to a difference of average specific gravity, if it exist, in the land of the two hemispheres, through a great metalliferous deposit in one, and a more cavernous texture in the other.

The great continental mass ranges from north-east to south-east, thus crossing the earth's diurnal motion from west to east, but what was the direction of former continents we do not know; it may at some periods have been widely different from what it is now.

Passing for the moment from the consideration of the disposition of land and water masses as affecting climate, and through that acting upon civilization, another important influence of such arrangements must be noticed, and that is the facility they afford, or the difficulties they oppose to, intercommunication and commerce. Hitherto lands much indented by seas and navigable rivers have had an enormous advantage in this respect over massive continents; and the advance of Europe, as compared with Asia, has, in no small degree, been occasioned by the extent and sinuosities of its coast lines. In Europe there is a mile of coast for every hundred and eighty-seven square miles of surface; in Asia the proportion is one mile of coast to five hundred and twenty-eight square miles of surface; in Africa one to seven hundred and thirty-eight; in North America one to two hundred and sixty-six; in South America one to three hundred and thirty. But we now live in an epoch in which human invention modifies the value of these conditions, great continents are being traversed by railways, even before roads are constructed, and ultimately this may more than compensate for their deficiency in coast.

The physical characteristics of the different continents are peculiarly interesting:—"Europe is, on the whole, a hilly and mountainous country. Asia contains the loftiest mountain groups of the globe, and also vast plateaux. Africa has its lofty mountains and elevated plains. Deserts very little above the sea level accompany the plateaux; but are small in comparison. America, notwithstanding the important and lofty chains of the Andes and Rocky Mountains, is mostly characterized by its plains. The high lands are a fringe of plateaux, and the gigantic valleys, of which those of the Mississippi, the Amazons, and La Plata are examples, are low plains. Mountains, except in the great chain of the Andes, in Central America and on the west coast of the Andes, are subordinate,

the important cultivation and vegetation of the continent being dependent on the broad, rich, level tracts that reach for thousands of miles in successive terraces, almost unbroken by hills, through a large part of both divisions of America."

Europe is the most complicated of continents. America and Australia are both simple, the one with its great mountain system in an almost continuous line, and its chief drainage in one direction; and the other with its prosaic destitution of great features, either mountain, lake, or river.

Variety of conditions and influences being essential to the progress of civilization, it is interesting to observe the tendency of different regions of the globe to assist or to hinder human advancement. Monotonous climates and monotonous countries tend to induce a stationary and conservative condition of the human mind, and had it not been for the warlike irruptions made from time to time by more impetuous mountain races, the inhabitants of great plains would have sunk into a state of vegetative repetition of the same forms of life, and of the same habits. The existence of variety to stimulate, and of difficulty to render industry indispensable, both of which arise, to a great extent, out of conditions of physical geography, exert the most powerful influence on the education of the human race; and if we understand the structure and position of different countries, we can easily see where civilization can be an early, and where it must be a late condition of the inhabitants.

A school of *un*philosophers has lately been trying to grow up amongst us, who caricature the doctrine of race, and who think themselves wiser than other persons, because they are unable to perceive that the mobility of certain races and the stationary character of others are intimately connected with the conditions under which they have existed. Such shallow reasoners feel no scruples in laying down the law that certain races must be extirpated, and that certain others must be enslaved, and they raise a sort of hyena laugh against those who believe that, by applying principles of justice, benevolence, and industry, all the great branches of the human family may be at last raised to a participation of the blessings of liberty and civilization. The unchangeable habits of savages are paralleled by the unchangeable habits of the pauper and criminal class in European countries, and yet there is no distinction of race between the tramp and the tradesman, the hereditary pickpocket and the thriving artizan. If a large portion of Africa is pointed out as the abode of races who do not improve, we ask, why should they? When have they been subjected to the operation of causes similar to those which have led Europeans in their progressive career? And if we look a

little farther, we shall see that the physical geography of Africa has opposed difficulties to the advance of civilization which we do not yet know how to overcome. In like manner immense tracts of country on the borders of the Amazon cannot, from considerations of physical geography, become the home of a numerous and cultivated population, until gigantic means can be employed to cut away its rampant vegetation, and drain its enormous swamps. In dealing with Africa, the difficulties are physical and moral, and the beneficent influence of the European mind upon the African mind can only be exerted successfully by a combination of powerful countries like England, America, and France, to compel the cessation of the slave trade, and establish honest, commercial settlements at the most convenient points.

Professor Ansted has an interesting chapter on the efforts of human agency in modifying the earth's surface, and there is every reason to believe that, within a few generations, the conditions of prodigious tracts of country will be greatly improved. India is undergoing an enormous change, through the restoration and extension of works of irrigation, and the impulse given to cultivation by the augmentation of means of transport. The slave states of America are passing from barbarism to civilization, and in a generation or two, millions of educated men will replace millions brought up in a condition little above that of domestic animals, swamps will be drained, waste land reclaimed, barren land cultivated, and thus many thousands of square miles will experience a considerable modification of climate as well as of aspect. When sandy wastes are sufficiently near centres of civilization to be worth the cost of modifying, we find them gradually converted into pasture and forest. First, certain plants are grown which give stability to the shifting mass, and other plants succeed them, and, in time, trees with their power of attracting moisture and protecting the soil from evaporation, rear their heads. Even in certain extensive deserts, it is believed that water for their fertilization might be obtained by artesian wells, and the constant demands of commerce for new markets and new routes of transit, tend to bring into importance tracts of country that have for ages been stationary, because the world's industry and invention had left them alone.

Apparently trifling circumstances may lead to considerable changes, as when the accidental introduction of a new plant or a new insect interferes with pre-existing arrangements and modifies the vegetation of a country or a district, thereby leading to changes in its supply of moisture, amount of evaporation, etc., etc.

It is, however, when civilization is most active, that man's

power over the earth becomes most apparent, and enters into rivalry with natural forces in producing modification. For immense periods it is probable that, *on the whole*, the amount of natural force at work to effect alterations of the earth's surface has been tolerably uniform in amount; but we who live in regions lying a little way out of the existing lines of maximum disturbance from action of fire, ice, or water, are apt to underrate the work that is going on from day to day. Wonderful is the amount of that work when fairly surveyed, and the time may arrive when fresh changes in the direction of disturbing forces may occur, and our own quiet regions may again be torn by earthquakes, fire-deluged by the volcano, or modified by glacial ice.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1867.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
April 1	30·410	46·7	36·6	·70	·333	56·2	30·4	25·8	0, 1, 9	WSW, W, W by S.	0·000
„ 2	30·136	52·5	48·1	·86	·406	61·8	46·2	15·6	10, 9, 4	W by N, W by S, W.	·003
„ 3	30·201	51·9	37·9	·61	·398	61·7	43·0	18·7	2, 1, 5	NW, WNW, W by N.	·002
„ 4	29·829	49·2	41·4	·76	·363	—	47·1	—	10, 9, 8	W, W by N, NW by W.	·000
„ 5	30·027	49·4	41·0	·75	·365	57·7	42·5	15·2	9, 10, 10	W by S, W by S, W.	·030
„ 6	30·009	51·0	46·1	·85	·386	60·8	44·5	16·3	10, 9, 9	W by N, W, W by N.	·002
„ 7	...	...	...	...	...	56·8	46·8	10·0	...	... ...	·000
„ 8	29·397	47·6	44·0	·88	·343	56·4	43·4	13·0	10, 10, 10	W, W by S, W.	·010
„ 9	29·717	47·4	34·3	·63	·341	56·0	43·3	12·7	6, 7, 7	WNW, W by S, WSW.	·133
„ 10	29·801	45·4	39·7	·82	·318	54·1	33·0	21·1	8, 10, 10	SW by W, SSW, SW.	·010
„ 11	29·720	42·9	33·8	·73	·292	54·3	44·3	10·0	10, 7, 9	W by S, NW by W, N.	·000
„ 12	30·170	47·5	33·0	·60	·342	56·2	34·5	21·7	2, 7, 5	NW, SW by W, SW by W.	·000
„ 13	29·934	45·0	45·2	1·00	·314	54·5	41·9	12·6	10, 10, 10	SW by W, SW.	·127
„ 14	...	...	...	...	...	54·1	47·3	6·8	...	... ...	·080
„ 15	29·564	47·6	38·2	·72	·344	56·0	45·6	10·4	7, 6, 3	W by N, WNW, W by N.	·311
„ 16	29·662	49·8	46·5	·89	·371	55·7	44·0	11·7	10, 10, 10	S, WSW, W by S.	·030
„ 17	29·869	49·7	46·3	·89	·369	61·2	45·3	15·9	10, 7, 9	ENE, WNW, NW.	·051
„ 18	29·836	51·8	48·5	·89	·397	62·3	44·5	17·8	5, 10, 9	S by W, S by E, S by E.	·020
„ 19	...	...	...	...	...	61·8	51·7	10·1	...	... ...	·000
„ 20	29·200	50·1	47·5	·91	·374	57·5	53·1	4·4	10, 10, 10	SW, SW, S by W.	—
„ 21	...	...	...	...	...	51·2	40·3	10·9	...	... ...	·300
„ 22	29·810	46·1	40·4	·82	·326	55·1	42·3	12·8	7, 10, 10	W, SW, S.	·013
„ 23	29·759	53·9	48·5	·83	·426	62·3	48·3	14·0	10, 9, 5	WSW, SW by S, S.	·060
„ 24	29·635	51·0	45·3	·82	·386	59·9	47·9	12·0	5, 8, 8	SW by S, SW, SW by S.	·113
„ 25	29·801	43·0	41·4	·94	·293	50·6	46·3	4·3	10, 10, 10	N, NE, NNE.	·193
„ 26	29·761	44·1	41·8	·92	·305	52·3	41·4	10·9	10, 10, 10	E by S, E, SE.	·010
„ 27	29·494	49·6	44·8	·85	·368	58·2	45·1	13·1	9, 7, 3	S, S by E, SW by S.	·033
„ 28	...	...	...	...	...	54·1	33·7	20·4	...	... ...	·010
„ 29	29·861	49·8	37·5	·65	·371	60·1	38·5	21·6	1, 1, 3	NNE, —, NE by E.	·000
„ 30	29·699	50·2	46·2	·87	·376	60·0	38·8	21·2	10, 7, 4	S by W, W, W.	·084
Daily Means.	29·812	48·5	42·2	·81	·356	...	...	14·2	...	... ...	1·625

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—April, 1867.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
Hour.																															
12	4	10	18	8	16	10	9	15	27	17	26	5	14	22	26	9	15	3	14	19	26	12	13	10	6	12	11	4	7	3	13·0
A.M. 1	4	11	15	12	14	5	9	14	26	13	23	4	13	22	30	11	15	1	14	16	24	10	12	11	6	12	9	1	7	3	12·2
2	4	10	12	15	10	6	8	12	29	13	25	4	13	24	25	11	14	1	10	15	23	11	10	7	6	11	4	3	5	4	11·5
3	2	9	11	19	5	8	13	15	25	9	28	3	16	25	24	11	15	3	8	15	25	10	9	11	8	11	4	2	7	4	11·8
4	4	8	13	15	4	9	13	15	22	4	29	4	14	27	24	8	15	1	12	17	27	10	11	16	5	10	7	3	7	6	12·0
5	3	10	10	14	1	12	7	19	22	7	30	5	17	24	25	10	10	1	11	20	26	10	11	15	5	8	7	1	6	11	11·9
6	3	10	4	14	1	11	11	16	25	6	30	5	16	32	25	8	8	3	12	21	28	14	14	14	5	8	5	2	6	11	12·3
7	7	10	9	17	3	16	9	21	28	9	33	4	17	30	28	11	7	5	15	21	29	16	11	18	6	11	8	4	6	9	13·9
8	7	12	14	13	5	13	11	21	31	11	27	4	15	30	24	12	7	6	15	24	30	18	14	21	6	12	11	7	6	10	14·6
9	6	9	16	21	13	21	13	22	31	11	29	6	17	33	23	10	6	11	20	24	31	17	17	23	3	11	12	10	6	13	16·2
10	13	13	14	15	13	16	14	22	27	16	29	7	17	39	27	12	4	14	21	21	27	17	17	20	14	13	13	12	7	13	16·9
11	14	18	16	18	15	17	17	19	28	17	33	7	18	36	26	11	3	13	22	22	29	15	15	25	14	13	17	12	6	10	17·5
12	14	19	13	24	15	17	13	24	31	20	32	9	18	38	24	10	6	18	29	27	30	15	15	27	13	15	17	14	9	15	19·0
P.M. 1	16	18	12	21	17	18	18	27	26	22	31	10	21	36	25	14	5	13	21	21	25	15	16	26	14	13	14	13	6	18	18·4
2	16	15	15	24	16	18	22	31	26	23	24	10	20	32	25	17	11	11	24	15	27	15	18	29	12	12	19	15	6	16	18·8
3	17	10	14	24	18	12	24	34	25	24	26	9	18	30	26	18	12	10	23	19	30	15	17	26	13	11	21	15	5	18	18·8
4	15	14	12	26	19	14	24	33	25	20	22	13	15	25	27	17	11	7	27	19	29	13	23	23	13	10	20	16	3	14	18·3
5	12	16	7	21	19	12	16	27	26	26	23	16	15	30	24	14	4	6	26	21	20	8	24	22	13	10	18	15	3	14	16·9
6	10	15	10	15	19	14	19	32	24	27	9	14	15	27	29	15	3	6	21	20	20	9	19	20	10	14	14	7	5	11	15·8
7	10	13	10	14	17	13	24	33	25	28	5	11	15	29	18	14	2	5	20	17	17	10	14	20	14	15	12	8	7	10	15·0
8	13	16	9	11	12	10	22	30	19	30	1	10	19	29	12	15	1	5	18	24	16	10	12	16	12	15	10	7	6	10	14·0
9	8	13	9	13	14	10	21	31	17	27	4	11	20	26	10	15	1	5	18	29	13	10	8	12	11	15	7	6	6	11	13·4
10	12	17	12	13	14	9	22	33	18	23	1	10	23	30	10	14	2	9	18	30	12	10	13	7	13	14	5	7	6	8	13·8
11	11	11	12	14	11	8	16	29	17	23	5	11	20	29	10	12	3	12	20	25	14	10	11	8	10	12	6	5	2	5	12·7
12																															
Total Daily Movement.	225	307	287	401	291	299	375	575	600	426	525	192	406	705	547	299	180	169	439	502	578	300	344	427	232	288	271	189	139	247	14·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1887.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		Rain-
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
May 1	29·944	50·3	37·6	·64	·377	59·3	43·2	16·1	10, 8, 4	W by S, NW, W.	0·062
„ 2	30·056	50·5	43·5	·79	·380	60·0	37·1	22·9	1, 8, 10	—, E by N, WSW.	·000
„ 3	30·110	57·1	45·6	·68	·474	67·0	44·6	22·4	7, 2, 2	SW, SSW, SSE.	·000
„ 4	30·065	58·3	41·9	·57	·494	66·7	43·4	23·3	2, 1, 3	SSE, SE, ESE.	·000
„ 5	...	...	...	...	...	72·2	45·6	26·6	...	...	·000
„ 6	29·910	70·2	56·4	·63	·731	79·5	46·7	32·8	2, 4, 7	—, SE, SSE.	·000
„ 7	29·964	68·3	56·7	·68	·687	77·4	56·7	20·7	5, 7, 9	W, NW, N.	·000
„ 8	29·841	66·2	51·0	·60	·642	77·3	51·3	26·0	0, 3, 7	E by N, S, S by W.	·000
„ 9	29·909	62·3	51·9	·70	·564	70·1	51·1	19·0	5, 4, 10	SW by S, SE by S, SSW.	·000
„ 10	29·709	66·0	54·8	·69	·638	75·9	51·8	24·1	7, 5, 9	S by W, S by E, SE by S.	·000
„ 11	29·534	59·1	49·8	·73	·507	67·0	53·8	13·2	8, 7, 3	SW, SW by S, W by S.	·291
„ 12	...	...	...	...	...	57·5	46·9	10·6	...	...	·012
„ 13	29·610	42·6	39·4	·89	·289	49·6	44·1	5·5	10, 10, 10	ENE, E by S, E by N.	·025
„ 14	29·789	41·1	31·9	·72	·274	50·0	43·7	6·3	10, 10, 10	E by N, ENE, E by N.	·004
„ 15	29·873	40·9	31·2	·71	·273	48·5	41·6	6·9	10, 8, 10	NE, NE, NE by E.	·000
„ 16	30·040	41·3	35·6	·82	·276	49·4	41·4	8·0	10, 10, 10	ENE, NE by N, NE.	·000
„ 17	30·106	48·5	39·3	·73	·354	55·1	38·1	17·0	3, 10, 8	S, SW, S by W.	·003
„ 18	29·992	52·5	40·1	·65	·406	61·8	33·0	28·8	5, 3, 3	—, E, E by N.	·000
„ 19	...	...	...	...	...	63·2	45·4	17·8	...	...	·000
„ 20	29·591	51·9	51·5	·98	·398	62·3	49·5	12·8	10, 10, 10	NNW, N, —.	·003
„ 21	29·686	42·5	38·9	·88	·288	50·1	49·1	1·0	10, 10, 10	NE, NE, NE by E.	·300
„ 22	29·972	38·7	30·5	·74	·252	47·0	36·0	11·0	7, 8, 8	ENE, NE, NW.	·063
„ 23	30·059	42·1	30·7	·67	·284	48·9	32·4	16·5	7, 7, 8	N, NE by N, NE by N.	·065
„ 24	30·146	41·1	29·8	·67	·274	49·5	31·6	17·9	9, 10, 10	N, NE, E.	·003
„ 25	29·988	44·3	34·2	·70	·307	52·5	31·2	21·3	9, 10, 10	ENE, E, E by S.	·000
„ 26	...	...	...	...	...	66·8	44·9	21·9	...	...	·376
„ 27	29·591	54·5	47·8	·80	·434	64·1	49·6	14·5	4, 8, 5	S by E, S by W, SW.	·029
„ 28	29·794	58·1	49·7	·75	·491	69·0	47·9	21·1	10, 6, 7	S by W, SSW, SSE.	·015
„ 29	29·893	60·4	54·8	·83	·530	71·1	52·3	18·8	3, 4, 9	SSE, E, E.	·000
„ 30	29·998	58·4	55·6	·91	·496	69·2	51·9	17·3	4, 10, 10	—, —, SW.	·015
„ 31	30·096	60·0	51·6	·75	·523	71·1	47·5	23·6	10, 2, 5	W by S, SW, SW.	·019
Daily Means.	29·899	52·9	43·8	·74	·431	...	...	17·6	...	... ...	1·285

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.
† Rain and snow.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—MAY, 1867.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
A.M. 12	6	1	1	1	9	4	10	14	3	6	4	2	10	12	17	17	3	1	9	1	1	10	10	3	2	14	6	11	9	2	6	6·6
1	8	2	3	3	6	1	9	6	7	3	4	2	8	15	15	15	4	1	7	1	3	10	9	2	3	14	4	10	5	1	5	6·0
2	9	1	3	3	4	4	7	7	5	5	2	3	7	15	17	16	1	2	8	2	4	10	8	5	3	15	3	6	2	6	6	6·1
3	8	2	3	2	3	1	5	10	3	4	4	3	6	15	14	17	1	1	10	4	2	11	5	3	2	14	3	9	4	7	4	5·8
4	10	8	1	3	7	4	2	13	4	4	4	1	9	16	16	14	1	1	7	3	3	9	9	3	5	11	5	9	5	4	7	6·4
5	10	4	1	2	9	2	2	11	4	4	10	4	10	15	16	15	2	2	9	1	4	10	10	4	6	11	10	11	3	5	7	6·9
6	14	3	3	1	11	5	1	11	5	5	5	5	12	14	22	15	3	2	11	2	8	14	12	7	7	8	14	12	3	10	8	8·2
7	12	4	3	7	4	4	5	11	9	5	9	10	14	15	21	15	3	6	12	4	6	18	16	9	3	8	15	18	5	9	7	9·3
8	14	1	5	11	11	7	9	13	10	5	11	14	14	20	23	20	4	6	12	5	13	18	22	10	5	9	19	22	2	7	5	11·2
9	16	4	7	9	12	8	6	12	10	5	16	17	13	20	21	16	5	9	14	7	15	15	25	10	6	6	19	25	4	6	8	11·8
10	15	4	7	13	16	9	5	15	10	9	21	13	12	26	22	20	5	8	19	5	24	12	29	11	13	10	20	21	7	8	5	13·4
11	12	3	9	17	14	6	6	12	7	4	21	14	11	20	20	16	5	9	16	8	20	15	26	11	16	8	15	25	10	9	6	12·6
P.M. 12	15	4	8	17	16	8	8	14	6	5	21	16	12	27	20	17	4	9	15	11	18	13	27	10	16	13	18	26	9	10	10	13·6
1	12	3	9	16	17	9	7	14	7	14	24	19	10	25	20	11	4	9	16	4	19	11	22	7	17	16	18	29	9	7	11	13·4
2	11	10	9	14	15	11	7	18	5	16	18	17	9	24	19	9	8	11	12	7	18	10	26	6	19	17	23	30	14	11	10	14·0
3	9	4	9	15	17	10	8	16	5	19	18	14	8	24	20	12	10	11	10	3	22	11	23	6	23	17	22	24	17	11	9	13·8
4	12	8	10	15	12	16	11	12	3	16	20	15	8	23	19	9	7	15	9	4	18	15	24	5	22	16	21	20	15	8	11	13·5
5	9	6	11	15	13	13	11	15	3	13	19	11	10	21	18	7	7	15	6	4	17	14	20	9	21	14	22	19	18	7	10	12·8
6	7	5	6	12	9	7	9	12	1	12	14	10	14	23	17	9	7	13	6	5	17	14	19	6	23	8	21	16	12	6	10	11·3
7	8	5	8	14	5	8	14	12	2	6	10	14	17	19	18	12	5	10	4	3	15	15	15	6	21	7	19	14	7	8	9	10·6
8	7	6	3	13	3	4	12	8	6	8	7	13	14	17	15	3	8	9	2	4	10	9	7	4	18	6	16	10	4	6	6	8·3
9	5	6	3	10	5	7	15	7	5	5	5	11	15	14	16	6	5	8	3	2	9	10	6	3	20	4	15	5	5	6	5	7·9
10	3	6	4	9	7	11	17	5	3	3	4	10	13	15	16	2	6	8	3	2	11	12	4	4	19	8	13	9	4	5	6	7·7
11	2	2	2	8	3	12	14	2	2	2	4	1	10	12	15	17	3	4	9	2	1	5	8	3	2	16	6	10	9	1	5	1	6·2
12																																
Total Daily Movement.	234	102	128	230	228	171	200	270	125	180	272	248	238	450	439	296	112	175	222	93	282	294	377	146	306	260	351	394	174	164	172	9·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1867.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		Rain—read at 9·30 A.M.
Day of Month.	Barometer corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
June 1	30·093	65·2	50·7	·61	·621	74·9	46·2	28·7	1, 7, 4	S by W, SW, SW by W.	0·000
„ 2	...	...	...	...	...	78·1	50·3	27·8	...	... ...	·000
„ 3	29·736	52·5	51·1	·95	·406	61·0	55·5	5·5	10, 10, 10	NNW. NW by N, W.	·727
„ 4	29·947	54·5	46·9	·77	·435	64·5	46·7	17·8	7, 7, 6	W by N, WNW, WNW.	·030
„ 5	29·820	52·4	53·5	1·00	·405	60·9	45·9	15·0	10, 10, 10	S by W, SW, SW by S.	·095
„ 6	29·706	55·1	47·9	·78	·444	64·9	53·0	11·9	10, 3, 8	SW by S, SSW, SW by S.	·160
„ 7	29·720	54·0	49·2	·85	·428	64·6	51·4	13·2	8, 7, 6	W by S, SW by W, W.	·000
„ 8	30·077	54·3	45·0	·73	·432	63·3	46·7	16·6	6, 9, 7	SW, SW, SW.	·110
„ 9	...	...	...	...	...	68·7	51·2	17·5	...	... ...	·000
„ 10	30·265	65·5	50·8	·61	·627	75·9	50·1	25·8	0, 0, 0	WNW, WNW, —.	·000
„ 11	30·236	69·7	57·0	·68	·719	78·6	50·8	27·8	1, 1, 2	S, ESE, SE by S.	·000
„ 12	30·044	68·0	59·2	·75	·681	77·7	55·5	22·2	2, 4, 7	SW, W by N, NNW.	·000
„ 13	30·014	55·0	50·7	·86	·442	62·7	53·3	9·4	8, 9, 10	W, SSW, WNW.	·060
„ 14	29·840	50·2	45·0	·83	·376	61·9	51·7	10·2	9, 9, 9	NW, W by N, W by N.	·000
„ 15	29·995	49·1	42·6	·80	·362	57·9	44·5	13·4	6, 10, 10	NNW, NW, NNE.	·114
„ 16	...	...	...	...	...	58·5	47·6	10·9	...	... ...	·065
„ 17	30·130	51·1	47·5	·88	·387	61·3	47·7	13·6	9, 10, 10	NW by W, NW, N by E.	·000
„ 18	30·066	60·3	55·3	.84	·528	70·5	46·3	24·2	8, 6, 1	W by N, NW, N.	·000
„ 19	29·986	56·7	55·6	·96	·468	66.5	58·6	7·9	10, 10, 10	E by S, E, E by S.	·000
„ 20	30·023	53·1	52·7	·98	·415	61·7	52·4	9·3	10, 10, 10	NNE, NE by N, NE.	·000
„ 21	30·112	52·3	49·4	·91	·404	62·8	49·8	13·0	10, 10, 10	N by E, NE, N.	·000
„ 22	30·121	55.2	45·8	·73	·445	66·9	45·5	21·4	2, 3, 3	NNE, NE, NNW.	·000
„ 23	...	...	...	...	...	69·4	46·6	22·8	...	... ...	·000
„ 24	29·995	55·5	50·9	·86	·450	66·3	51·5	14·8	10, 10, 9	NW, N, NNE.	·000
„ 25	30·234	60·0	51·8	·76	·523	70·0	48·9	21·1	2, 3, 1	N, NE, NNW.	·000
„ 26	30·512	58·9	49·8	·74	·504	69·3	47·5	21·8	3, 1, 1	NE, NE, NE.	·000
„ 27	30·533	66·8	47·7	·53	·655	77·3	45·0	32·3	0, 1, 3	NE, N by E, NNE.	·000
„ 28	30·537	54·3	49·5	·85	·432	64·7	51·7	13·0	10, 5, 3	NNE, NE, NE by N.	·000
„ 29	30·344	62·1	50·2	·67	·561	74·3	41·0	33·3	1, 3, 3	SW by W, S by W, NW.	·000
„ 30	...	...	...	...	...	77·9	48·1	29·8	...		·000
Daily Means.	30·043	57·3	50·2	·80	·486	...	...	18·7	...	... ...	1·361

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES), AS RECORDED BY ROBINSON'S ANEMOMETER.—JUNE, 1867.

	Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
	Hour.																															
	12																															
A.M.	1	3	4	1	8	7	16	14	11	11	5	1	3	2	3	5	6	6	2	3	11	8	6	2	4	8	5	7	2	2	5	5·7
A.M.	2	2	1	5	6	6	15	12	13	8	5	0	3	3	3	6	4	3	1	3	10	9	6	1	8	9	5	6	4	5	4	5·5
A.M.	3	2	1	4	6	7	13	14	10	9	6	2	5	3	3	8	5	3	3	3	9	8	6	1	6	5	5	9	1	2	1	5·3
A.M.	4	2	1	5	5	5	13	9	9	8	4	2	4	4	2	8	3	3	3	4	11	9	7	1	5	7	10	7	5	3	3	5·4
A.M.	5	2	1	9	7	10	12	15	5	8	4	1	2	3	5	8	3	5	4	1	10	5	5	1	7	7	10	12	6	2	6	5·9
A.M.	6	3	0	9	8	12	12	14	4	10	6	0	2	4	4	10	4	5	5	4	10	9	5	1	8	7	10	8	8	3	1	6·2
A.M.	7	2	3	12	9	18	11	14	6	11	7	2	3	4	3	13	7	4	5	1	10	7	6	0	10	7	15	13	13	0	3	7·3
A.M.	8	10	2	4	10	21	17	16	6	12	7	7	5	4	5	16	8	7	5	3	9	9	8	4	10	11	15	11	15	3	2	8·7
A.M.	9	14	2	5	9	22	17	16	6	10	8	5	8	6	8	14	10	7	6	3	10	9	9	6	13	14	15	7	17	2	3	9·4
A.M.	10	15	4	4	11	17	18	13	9	12	10	8	8	8	7	16	7	6	8	6	9	9	6	5	12	8	17	9	18	2	2	9·5
A.M.	11	14	14	5	5	20	19	14	10	11	13	11	10	11	13	16	13	11	6	7	9	11	8	12	13	18	19	19	6	6	3	11·6
	12	15	10	5	5	23	23	14	11	11	10	9	12	10	9	17	12	6	6	9	10	8	6	11	12	15	20	18	6	6	3	11·1
P.M.	1	14	10	8	7	21	23	18	12	11	10	10	9	12	12	14	11	6	7	12	11	9	8	14	11	18	20	17	4	6	3	11·6
P.M.	2	14	7	11	14	24	26	12	10	7	10	8	11	10	12	11	10	9	8	10	11	10	5	10	13	18	18	14	7	6	4	11·3
P.M.	3	13	13	16	12	25	26	14	15	8	10	12	11	11	15	12	8	6	9	6	12	8	4	13	12	19	19	19	6	6	7	12·2
P.M.	4	12	13	17	13	25	26	11	17	9	9	12	13	8	15	10	12	5	13	9	10	10	5	12	14	18	19	15	6	3	10	12·4
P.M.	5	14	13	15	14	24	25	10	19	9	6	13	10	8	14	10	9	9	14	10	10	10	7	10	15	20	19	17	8	5	12	12·6
P.M.	6	12	12	11	14	23	24	10	18	7	6	12	9	7	5	6	5	5	11	10	8	8	3	11	15	17	19	13	10	3	15	11·0
P.M.	7	12	9	10	11	20	18	13	15	8	4	9	9	6	8	5	5	5	11	7	9	9	4	10	13	17	15	6	8	2	11	9·6
P.M.	8	8	6	9	9	20	18	14	15	4	4	5	8	8	5	6	8	7	6	8	9	7	3	5	13	13	13	4	6	6	7	8·5
P.M.	9	6	6	7	6	18	15	10	12	4	3	4	7	5	7	4	1	5	2	7	7	7	5	5	11	10	10	4	9	4	4	6·8
P.M.	10	4	4	6	6	21	10	10	15	4	6	4	3	5	6	2	4	4	5	7	7	6	5	2	12	12	10	3	7	1	4	6·5
P.M.	11	5	2	6	11	18	15	10	14	4	2	5	4	5	6	5	4	2	4	11	9	7	5	3	12	10	5	5	7	7	1	6·7
	12	3	4	6	5	17	11	9	11	6	0	2	3	3	6	5	2	2	3	10	8	6	3	2	12	8	2	4	6	7	7	5·8
	Total Daily Movement.	201	142	190	211	424	423	306	273	202	155	144	162	150	176	227	161	131	147	154	229	198	135	142	261	296	315	247	185	92	121	8·6

PROGRESS OF INVENTION.

Economic Production of Formic Ether, on the Large Scale.—The peculiar odour of the peach, possessed by this compound, has recently given to it an importance that renders any simplification or diminution of expense during its manufacture a matter of interest. It may be very conveniently made by placing a mixture containing twenty-nine parts, by weight, peroxide of manganese, and nine parts starch in an alembic, and sprinkling it with a mixture formed with twenty-eight parts sulphuric acid, five parts water, and fifteen parts alcohol, and, after agitation, closing the alembic. Distillation takes place generally without the application of heat; the products being, first, alcohol, then nearly pure formic ether, and, finally, formic acid. Before sprinkling with the alcoholic mixture, the latter should be cooled, or the action may be far too energetic.

Improvement in the Manufacture of Steel.—In the old mode of forming steel all the carbon is removed from the cast iron, malleable iron being formed; and steel is made from this malleable iron by the addition of the proper amount of carbon. By the Bessemer process only enough carbon is removed from the cast iron to change it to steel; and the carbon is removed by the introduction of an abundance of atmospheric air into the cast iron in a state of fusion. The oxygen of the air burns the carbon. It might be supposed that any substance capable of affording oxygen, introduced into the fused cast iron, would answer instead of atmospheric air; and therefore the use of substances, such as nitrate of soda, etc., capable of furnishing large quantities of oxygen, was very soon attempted. But it was found that the very property possessed by these compounds of affording oxygen, caused them to rapidly destroy the converter—a vessel in which the change from cast iron to steel was effected. Not only was the carbon of cast iron, but the metal of which the converter was formed, burned. This was, of course, fatal to the employment of these salts as a source of oxygen. The difficulty was, however, not insuperable, and it has since been overcome. The converter is lined with a refractory material, and the nitrate is placed in pockets formed in this material. The cast iron is brought in contact with the nitrate, by means of a rapid rotation imparted to the converter: and the centrifugal force thus generated throws the fused cast iron into violent collision, and therefore complete contact with, the salt.

New Breech-loading Gun.—A safe and very simple breech-loading gun has been recently invented in France. The gases generated by the explosion are prevented from escaping at the breech by the application of the principle used by Bramah to render the pistons of hydraulic presses water-tight, however great the pressure. Attached to the screw that forms the breech of the gun, is a thimble of soft copper which protrudes into the barrel, and when the gun is fired its sides are expanded by the gases in all directions, so that no gas or vapour can escape between it and the barrel. There

is no trigger, and therefore it is impossible that the gun can go off by accident. The needle which ignites the explosive compound in front of the powder, passes into the screw which forms the breech, being kept back in its normal position by a spiral spring: it abuts against a thin elastic plate that closes the aperture in the screw, and does not project beyond the general surface. When the gun is to be discharged, the thumb of the right hand is pressed on the elastic plate. This forces in the needle, and ignites the detonating compound.

Improvements in Galvanic Batteries.—If the nitric acid in the Bunsen battery is replaced by an aqueous solution of picric acid, the evolution of disagreeable and unwholesome gases will be prevented, while the efficiency of the battery will not be injuriously impaired. The dilute sulphuric acid may be replaced by a solution of sea salt. The addition of picric acid also to a battery containing but one fluid greatly improves its action. The resistance to the current caused by the porous vessel of a Daniels battery is removed by a slight modification of its details. Within the outer vessel, which may be made of glass or porcelain, is placed a cylinder of copper much smaller than the outer vessel, but having attached to its lower end a disc of copper that just fits on the bottom of the outer vessel. Between the latter and the copper cylinder is the diaphragm, a cylinder of glass or ordinary porcelain, having on the outside, at the distance of one-third of its height from its lower extremity, small projections for supporting a cylinder of zinc. This battery is charged by placing siliceous sand in the interior of the diaphragm, and on this sand crystals of sulphate of copper; then pouring a solution containing about five per cent. sulphuric acid gradually into the outer vessel, until it reaches the crystals of sulphate. The electricity passes directly from the zinc to the copper disc, without being retarded by passing through a porous vessel. If the exterior vessel is glass, any deposit of copper on the zinc can be perceived at once and prevented. The greater the number of times per day the battery is to be used, the more permeable ought to be the sand, that the sulphate may be supplied with sufficient rapidity. The stratum of dissolved sulphate must never be allowed to rise high enough to come in contact with the zinc; if it is becoming too high, sand is to be added, or some of the liquid within the diaphragm is to be removed with a syphon—which will cause the sulphate to be driven back, on account of the greater height of the liquid in the external vessel.

Improvements in Plating and Gilding.—The danger to the workman from contact with mercury is entirely prevented in gilding and plating, by dipping the article to be gilt or plated in the solution of a *basic* salt of mercury while in connection with the positive pole of a galvanic battery, and, when it is covered with mercury, immersing it in a strong solution of the gold or silver salt; then plunging it a second time in the mercurial solution, and afterwards evaporating the mercury in a furnace. Or the article which is to be gilt may be dipped into sodium amalgam, the surface of which has been covered with a little water, the portions which are not to be

gilt having been protected with varnish; after which an amalgam of gold is to be applied, and the mercury is to be evaporated by heat. Amalgam containing only the one two-hundredth part sodium will be sufficiently active to amalgamate tarnished metals, or iron and platinum, which, in ordinary circumstances, have no tendency to become wetted with mercury.

Improvement in Horological Machines.—It is scarcely too much to assert that the rate of a well-constructed clock or watch would be invariable, but for alterations of temperature. With an increase of temperature the pendulum is lengthened, and consequently its vibration is rendered slower; with a decrease, the contrary takes place. Analogous effects are produced by changes of temperature on watches and chronometers: and as, during summer and winter, night and day, the temperature of the air is perpetually changing, it may well be supposed that without the adoption of some means for counteracting the effects of changes of temperature, the rate of clocks, watches, and chronometers would be subject to perpetual alteration; and such is the case with ordinary horological instruments. But ingenious means have been devised for compensating the changes produced by temperature. These means, however, are subject to two considerable drawbacks: they are more or less complicated and therefore expensive, and they are rarely as perfect in their action as might reasonably be desired. A new mode of compensation for clocks, watches, and chronometers has been invented by M. Menon, which is extremely simple, and therefore inexpensive; and very effective, because calculated exactly to counterbalance the effect of changes of temperature, by bringing into opposite actions two precisely equal forces. In the compensations hitherto in use, the expansions and contractions of different substances are made to counteract each other; and thus, from the difficulty of making them exactly equal in their operations, a serious source of error is introduced. With the gridiron pendulum, for example, the rods which raise the bob of the pendulum may not expand to the same degree as the rods of a different metal which lower it: and the raising and lowering may thus not be equal—that is, the length of the pendulum may vary. With the mercurial pendulum, the centre of gravity of the mercury may not be altered in position so as exactly to counterbalance the alteration in the length of the pendulum rod produced by change of temperature. In M. Menon's contrivance, the two portions of the compensation are exactly the same in every respect, and therefore when their expansions or contractions are made to neutralize each other, the effect must be zero—that is, the length of the pendulum must remain unchanged. In the construction of a compensation pendulum on this principle, two rods of the same metal, and of the same dimensions, are used; the pendulum is attached to one, and the other is coiled up—merely for convenience, the alterations produced by change of temperature being exactly the same whether the rod is in the form of a right or curved line. The rod, in the form of a spiral, is used to suspend the bob of the pendulum, or the pendulum itself. For this purpose, one end of it is fixed to the bob, which

is easily moveable on the rod, and the other is connected with the rod: or one end is fixed to a support, and the upper end of the pendulum is attached to the other—the arrangement being such that when the spiral rod expands or contracts, it raises or depresses the bob on the pendulum rod, or raises or depresses the pendulum itself through the fork: the effect being a practical shortening or lengthening of the pendulum exactly to the extent that the change of temperature has lengthened or shortened the pendulum rod; the acting length of the latter, therefore, never alters. In applying this principle to the watch or chronometer, the spiral spring and the compensator are made of the very same material and dimensions: and it is so arranged that, when change of temperature alters the length of the spiral spring, the same change alters that of the compensator which acts on the "regulator;" and thus the length of the acting part of the spiral spring is kept without change.

Improvement in the Safety Valve.—Without an effective and reliable safety-valve, the use of a steam-boiler must be constantly attended with the most imminent danger. Whatever care may be bestowed by the manufacturer on the construction of the safety-valve, it may be rendered nugatory by the ignorance or temerity of the person in charge of the engine: since he may overload the valve, and thus create a pressure within the boiler which it was not constructed to endure, and which it may not be capable of bearing. The evil may indeed be prevented by the use of two safety-valves, one of which is beyond the power of the engine man. But ingenuity has devised a still more simple remedy; one that not only prevents the production of steam at too high a pressure, but which actually causes every attempt to produce it to be accompanied by a reduction of pressure, and thus removes all temptation to tamper with the valve. The new form of safety-valve differs little from the ordinary kind, and is extremely simple. In the ordinary kind the fulcrum of the lever is absolutely immovable: in the new kind, it is fixed; in ordinary circumstances, being kept down by a spiral spring. But attempting to overload the valve brings the lever down on a stud, which is at the side of the valve most remote from the fulcrum, and which comes into action as a new fulcrum by supporting the lever, changing the latter from the third to the first order. The former fulcrum yields to the additional weight, the spiral spring being compressed, and is raised up, the safety-valve being at the same time opened, or allowed to open; and thus the steam is permitted to escape, though at a pressure too small to raise the valve when weighted as it should be. In its normal state the fulcrum of the lever is at one end, the weight at the other, and the power—that is the tendency of the safety-valve to rise—between the fulcrum and weight. When the valve is overloaded, the weight—that is the resistance of the spiral spring—is at one end, the power—that is the weight with which the lever is loaded—is at the other, and the fulcrum—that is the stud on which the lever has been brought down by the overloading—is between the power and weight: the effect of the latter being aided by the tendency of the steam to raise the valve.

A New Glass for Optical Purposes.—The density imparted by

thallium, as illustrated in thallic alcohol, suggested the application of that metal to the production of a very dense, and therefore highly refractive glass; and experiments made on the subject have been extremely successful. Difficulties of a serious character were encountered at first, the glass produced being fibrous, and not very transparent; but these have been overcome by the assistance of M. Feil, a glass manufacturer of great experience, and a thallic glass in every respect suited to optical purposes has been obtained. When carbonate of thallium is employed in its manufacture, its tinge is yellowish; but if this is considered an objection, the substitution of sulphate for the carbonate affords a perfectly colourless result. Thallic glass is the most dense, and the most highly refractive and dispersive known.

Magnetism and Diamagnetism of Gases and Vapours.—A simple and effective experiment by which the magnetism and diamagnetism of gases and vapours may be rendered visible to a large audience has long been sought for, and has at length been discovered. It consists in blowing a bubble at the end of the stem of a clay tobacco-pipe, the gas used for inflation being oxygen, and the fluid a solution of soap mixed with glycerine, which affords a bubble that lasts a considerable time. The bubble is placed above the poles of an electro-magnet, and at very small distance from them. When a current is sent through the coil of the electro-magnet the bubble is attracted, and if the circuit is completed and broken several times in succession, a very striking oscillation of the bubble will be produced. If magnesium is burned over the pole of an electro-magnet to which a conical form has been given, when the circuit is complete, the smoke will be divided laterally, and assume the form of the letter U.

LITERARY NOTICES.

The Constellation-Seasons: An Easy Guide to a Knowledge of the Stars. Exhibiting, in Twelve Planispheres, the Appearance of the Heavens at any Hour of the Night, all the Year round. By Richard A. Proctor, B.A., F.R.A.S. (Longmans.)—Mr. Proctor has produced one of the most useful series of maps we have seen for the purpose he had in view, namely, enabling students to learn the position of the chief stars and constellations at various periods of the year, or to recognize them at any time. "Each map," he tells us, "contains the whole of the visible heavens at the hour and date mentioned beneath it; the centre of the map is the point over the observer's head at the time named; the outline of the map is the observer's horizon; each star is placed in its proper direction as respects the compass-points (marked in round the map); and each star is placed at its true proportionate distance from the centre." For the teaching of young people, and for adults who wish to know the position of particular stars at certain dates, these maps will be

found very handy. Mr. Proctor has devoted great labour to their production, and he deserves the sincere thanks of all who wish to see the elementary facts of stellar astronomy simplified. They will be of important value to amateur telescopists.

A Handy Book to the Collection and Preparation of Fresh Water and Marine Algæ, Diatoms, Desmids, Fungi, Lichens, and Mosses, and other of the Lower Cryptogamia, with Instructions for the Formation of an Herbarium. By Johann Nave. Translated and Edited by the Rev. W. W. Spicer, M.A., F.R.M.S. (Hardwicke.)—This is really what it calls itself, a "Handy Book," with twenty-six plates, and elaborate directions for collecting and preserving the objects to which it alludes. It will be found of much use to beginners. The information is conveyed in a very clear and simple manner.

A Treatise on Punctuation, and on other Matters relating to Correct Writing and Printing. By an Old Printer. (Pitman.) —Good punctuation is an immense aid to the intelligibility of a book, and many works of merit are quite puzzling to read for the first time, because their punctuation has not been made upon a good system. The little book before us is well conceived and judiciously executed. We recommend it to all who desire to learn a simple but necessary art.

NOTES AND MEMORANDA.

Neptune's Grotto.—Under this title some ingenious person has brought out a pretty chemical toy, which we saw in operation at Messrs. Horne and Thornthwaite's. A white solid is put into a clear solution, and thereupon beautiful arborescent and other forms are seen to grow in the course of a few minutes. If the experiment is performed on a small scale in a little zoophyte trough, under the microscope, and viewed by *reflected* light, with a 1½-inch objective, the effect is singularly beautiful. A chemist will easily recognise the materials employed. They give rise to a double decomposition, and the precipitation in crystalline form of an insoluble salt of lead.

Volcanic Action in the Azores.—M. St. Claire Deville read to the French Academy a letter, dated Angra, June 7, 1867, published in the journal "A Persuaso," at St. Michel, in the Azores, stating that, from May 26, they had experienced strong earthquakes, and that in the night of June 1-2, a volcanic vent was formed nine miles north-west of Serreta, which continued active, and occupied a zone of more than 2½ miles in a westerly direction. The writer states, "It was in the sea, lat. 38° 52′, and long. west of Greenwich 27° 52′, in a line from Tercera to Gracioza. It constantly emits great stones and enormous masses of lava, the accumulation of which may produce a new islet, likely to be dangerous. Jets of vapour and boiling water appear in different positions, and for a considerable distance a strong odour of sulphur is noticeable. From time to time noises are heard like repeated discharges of artillery. The Intendant of the Marine, various civil and military engineers, and others, have gone off to survey these phenomena, but the danger has kept them at a considerable distance.

Medicines through the Nose.—M. Raimbert recounts to the French Academy various experiments in administering medicines in the form of a snuff, to act by absorption through the membrane of the nose. Sugar powdered with hydrochlorate of morphia, and taken in this way, he found useful in violent

headache. He mixed five centigrammes of the morphia with two grammes of powdered sugar, and in some cases strengthened the dose. He thinks digitalis, nux vomica or strychnine, iodide of potassium, calomel, etc., may be administered with advantage in this way.

THE LEPORIDES.—Some time ago there was a good deal of talk about the leporides, or crosses between hares and rabbits, that were alleged to be raised in considerable quantities by an enterprising Frenchman. Dr. Pigeaux, writing in the "Bulletin de la Societé Imperial Zoologique d'Acclimation," observes, "To sum up, therefore, we would affirm that leporides exist, undoubtedly, under both forms, with predominance of the hare or of the rabbit; but as a species, or even as a variety, we cannot admit them, since, like all other crosses, they have only an accidental productiveness." He adds that their flesh has neither the whiteness of the rabbit nor the flavour of the hare.

COAL-FIELDS OF BRAZIL.—A paper read before the Geological Society shows the existence of large coal-fields in the province of St. Catherine's, Brazil. The coal is found to be of good quality, and its profitable working will depend on facilities for transport.

METEORIC APPEARANCES ON JUNE 11.—We have received the following from Mr. D. A. Freeman:—"It was stated in the 'Gazzata Ticinese' of June 20, that in several of the Swiss cantons, at Basle, at Zurich, at San Gall, at Geneva, there was observed on June 11, at 9 p.m., the sky being serene, a meteor of great splendour, which for an hour showed remarkable changes, and terminated by assuming the appearance of a small cloud."—[*From the "Opinione," published at Florence, June* 23.] We find in "Comptes Rendus," June 17, the following letter from M. Silbermann, referring to a remarkable meteor seen by him about the same time:—"Thursday, June 11, at 8.10 p.m., a shooting star, more brilliant than the finest of 13th November last, passed a little north of the zenith, moving with extreme slowness from the west to the north-east. I reckoned that it took two seconds and a half to traverse an arc of about 20 degrees. Before becoming extinct it manifested a remarkable recrudescence of splendour, shooting forth yellowish green sparks. Before the last instant it was exactly like a *fusée d'artifice*, burning with white fire. M. Louft at Palaiseau, and M. Auzou at St. Aubin d'Ecroville (Eure), inform me that they noticed the same facts." In "Comptes Rendus," June 24, M. Bonnafont states:—"On the 11th of this month, at 8 to 8.15 (about), I was sitting in my garden at Antony, near Paris, when towards the north a splendid meteor appeared. Its form appeared to resemble an enormous Congreve rocket (*fusée a là Congreve*), with a red incandescent point in front. Immediately afterwards this body exhibited a very brilliant yellow-white colour, like a hood, over two-thirds or less of its length, from which streamed an incandescent, hairy train, leaving considerable traces in the atmosphere. M. Barba, engineer of the Imperial Marine, studying the points I indicated to him, was able to lay down its exact trajectory. At the moment the bolide appeared to me, it was N. 3° E. of the meridian of Paris, and 22° 30 above the horizon. It then described a parabolic curve, with the convexity towards the zenith, and constantly approaching the horizon, disappeared in a few seconds behind my house, at 34° N.E. Its height above the horizon was then 16°."